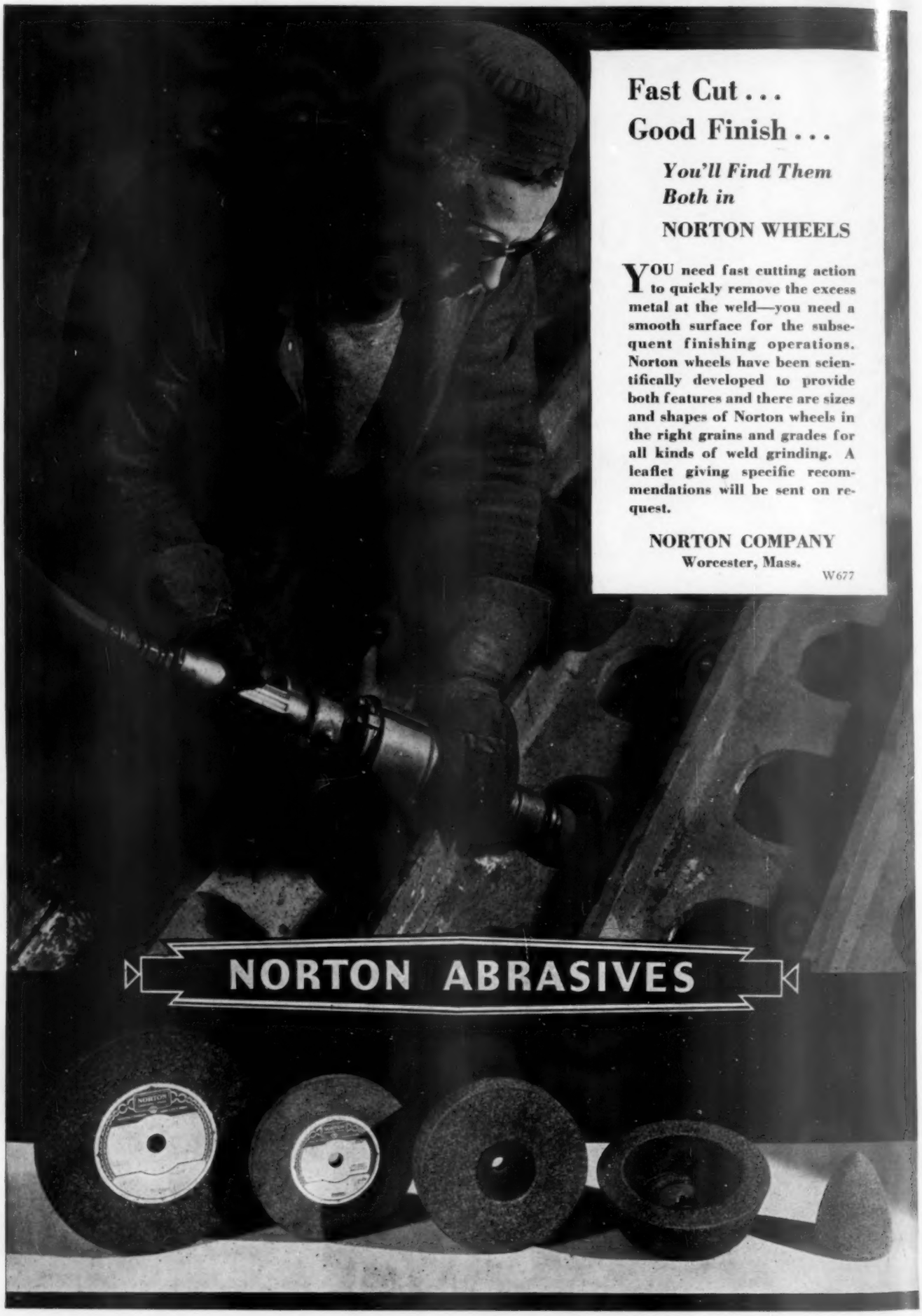
The Welding Engineer

PIONEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

Volume XXIV August, 1939 Number 8

SEP 8

Huge 12,500 HP. Vertical Motor For Single-Stage Centrifugal Pump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Published on the 15th of each month by The Welding Engineer Publishing Company, 506 South Wabash Ave., Chicago, Ill.
Telephone Webster 7134.

Advertising copy must be received not later than the 5th of each month.

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"12,500 HP. Vertical Motor For Single-Stage Centrifugal Pump"—This is one of six huge motors built by Westinghouse Electric & Mfg. Co. for the Metropolitan Water District of Southern California. The complete pumping unit can handle 200 cu. ft. per sec. against a 440-ft. head. Photo (Westinghouse Electric & Mfg. Co.).

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Subscription, payable in advance: United States and possessions, and Canada, $3 a year; Foreign Countries, $4 a year; Single copy, domestic, 25 cents; Single copy, foreign, 35 cents. Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

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Machine Design Textbooks

JUDGING FROM a new textbook submitted to us just recently for review in our columns, there is an urgent need for another A.W.S. Committee, with some such title as "Committee to Assist Authors of Machine Design Textbooks and Other Engineering Books." In the author's introduction of the subject of riveted joints, he tells the student, "When two pieces of metal are to be permanently fastened together, the riveted joint may be used. Its use is common in the construction of boilers, and other pressure vessels, steel chimneys (stacks), tanks, and structural work. While its field of usefulness has been rightfully encroached upon by welding, it still remains for many cases the best and simplest type of permanent fastening."

Considering the fact that he has devoted 25 pages to the design of various types of riveted joints as used in boiler and tank construction, we feel that his omission of any data on welded joints is really serious and gives the student a one-sided picture.

Dissolving Prejudices

OUR READERS are referred to J. F. Lincoln's thought-provoking article headed "Welding vs. Prejudice" on page 26 of this issue. Some of the present day restrictions placed upon welding seem rather silly and inconsistent as he points out. There is no question but standards of conduct are necessary but they should be based upon necessity for safety to property and individuals. Welding has come of age. "Welding must have parents," says Mr. Lincoln, "but there should not be so much doubt thrown on its paternity."

It is recognized that all engineering rigidities as stipulated in code restrictions, increase the cost of welded fabrication. After all, welding has to compete with other methods and it may be that some of these code restrictions are inspired by competitive jealousy. We cannot say that they are because we do not know. We also question whether anyone knows the full extent of restrictions which may be inspired in part by jealous motives.

How frequently should a welding operator be tested on important work? The answer depends on the degree of skill required of the operator to do a satisfactory job. Mr. Lincoln implies that the degree of skill required is almost negligible and cites as an example some recent tests conducted among welding students at his Cleveland plant. It is apparent from the test data that even first-week students were able to complete satisfactory tension specimens of weld-deposited metal. We presume that these were the standard .505 in. machined specimens. We question whether these tests are conclusive. To our mind they really demonstrated only the students' ability to make a "casting" of electrode-deposited metal. This type of test does not indicate fusion of weld metal to plate material, nor the welder's ability to make a weld that will conform to the dimensional specifications on an engineering drawing. In our opinion, the simple guided-bend jig test would have been a more convincing method of testing the students' welding ability.

Engineering Control of Welding

WE WISH TO direct attention of our readers this month to our lead article "Engineering Department Control of Welding," by Walter Brooking, of R. G. LeTourneau, Inc., Peoria, Ill. In this first section, the author emphasizes the need for effective control of the welding process in manufacturing operations. He presents a very strong case by citing the well-known fact that designers of riveted joints always specify the exact number of rivets of a certain size and strength, and furthermore, specify the exact arrangement of rivets. All of this information is shown on the drawings.

It is well known that a comparable degree of control in arc welded fabrication is not yet universal. As Mr. Brooking points out, material specifications are usually quite detailed, but the control of the welding operation is too often left to the judgment of the shop man. This results in an undesirable lack of uniformity. The welded joint may be more expensive than a properly designed joint. Conversely, an inadequate amount of weld metal may subject the structure to failure in service. Certainly , the engineer must assume the full responsibility for design of a structure. He cannot "pass the buck" to the man in the shop.

By means of the American Welding Society symbols, which are being more widely used as engineers and fabricators become familiar with them, it is possible for a manufacturer to obtain just as exact and complete control of the arc welding process as with any of the other methods of fabrication. We strongly urge our readers to study Mr. Brooking's article. His symbol explanations are very simple and easy to grasp.

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1. How can you safely recommend the use of larger electrodes at sustained high average amperage for faster welding? Answer: By specifying the new *"Shield-Arc."* Its motor is Self-Protected. It will not burn out.

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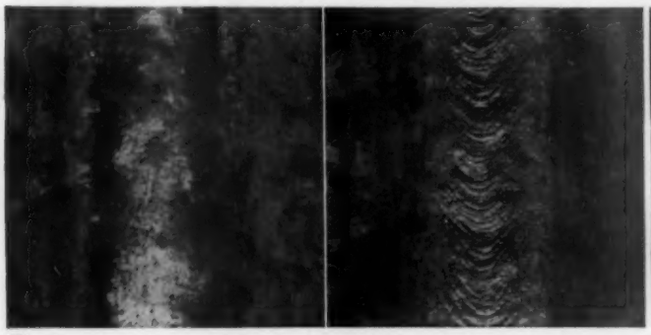

3. How would you produce an exceptionally smooth multiple-pass weld? Answer: Use "Fleetweld 10" on the last pass. This new Lincoln Electrode provides full slag coverage and makes a perfectly smooth bead.

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Engineering department
control of the

Arc Welding Process

★ Control can be just as complete as with older methods of fabrication—A.W.S. welding symbols have been found very satisfactory

By WALTER J. BROOKING
Engineering Department, R. G. LeTourneau, Inc., Peoria, Ill.

THE EXACTING demands of present day competitive business for products of high quality, produced at minimum cost, have resulted in an almost universal application of some method of control in manufacturing. This control functions primarily in the designing and engineering of the product.

The fabrication of iron and steel products by bolding or riveting cast or rolled steel parts together is usually carefully controlled. Every riveted joint, for example, is carefully studied from the standpoint of strength of material, thickness of material and maximum strain on the joint. The designer then specifies the exact number of rivets of a certain specified size and strength to be used in the joint, and further specifies the exact arrangement of rivets. These specifications are shown on the blueprints of the structure, and serve: (1) as a basis for accurate ordering of parts, (2) as a written order to the supervisor and the operators who fabricate the product, (3) to establish requirements to be met for passage by the inspection department, (4) as an accurate basis for calculating costs of materials, and (5) in cases where a labor incentive system is used, to establish a uniformity of procedure and an amount of work which the time study department can consider standard.

The practice of such detailed control in the arc welding process of fabrication is not so universal. The specifications for the parts used are quite complete and detailed, because they are usually made from standard rolled steel plates, bars or shapes: but the control of the actual unification of the parts by the arc welding process is very often left to the shop. The immediate result is a lack of uniformity of product; a product which is either overwelded and more expensive, or a product that has not enough weld metal correctly applied and is subject to failure in service.

Control of the arc welding process from the engineering department can be just as exact and complete as the control of any of the older methods of fabrication of machinery from steel such as bolting or riveting. A system of welding symbols, codified and generally accepted the same as any other system of engineering symbols, has been set up and found to be satisfactory. The symbols are those set up by the American Welding Society, and accepted by the American Society of Mechanical Engineers as the standard method for giving detailed welding information on blueprints. The fact that the United States Government, many of the large steel companies and several of the leading manufacturers of arc welded products use the A.W.S. welding symbols indicates that they are sufficiently standard and practical to be of use.

The American Welding Society symbols show three main things about a weld: first, the location; second, the type of weld; and third, the size of weld. Additional information may be added by the individual company if it is necessary. Our company therefore saw fit to add symbols which show the position in which the weld is made (flat, fillet, vertical, etc.) and the number of separate beads of weld metal required for each weld. The additional

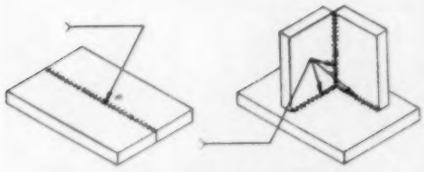


Fig. 1—Symbol arrow showing location of welds.

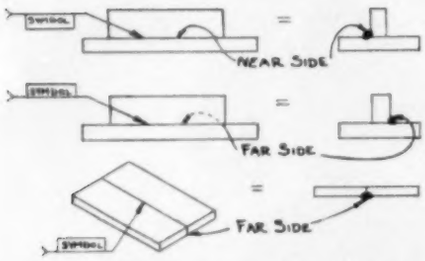


Fig. 2—Main body of symbol is placed below or above shaft line of arrow to indicate "near" or "far" side for weld.

information was added to make possible the application of exact control to all phases of the welding process, so that the standards system employed in our factory could be applied to welding.

Description of Welding Symbols

LOCATION—The framework of the symbols is an arrow, the shaft line of which is to be considered the center line of the plate to be welded. The head of the arrow points to the joint to be welded, as shown in Fig. 1. The space between the forks of the tail is reserved for special information such as type of electrode to be used, or may be left blank.

To indicate whether the joint is to be welded on the side near the arrow or the side away from the arrow, the main body of the symbol is placed below, or above the shaft line of the arrow as shown in Fig. 2. If a weld is to extend all around a part a ring encircling the front end of the arrow shaft designates it, as may be seen in Fig. 3. The relation of the symbol for near and far sides of the joint to be welded remains the same.

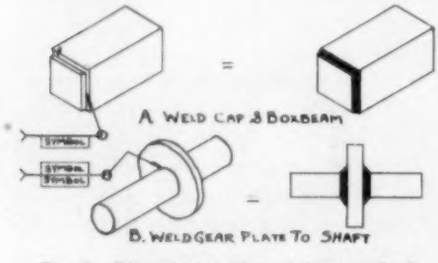


Fig. 3—Ring designation at front end of arrow shaft means "weld all around."

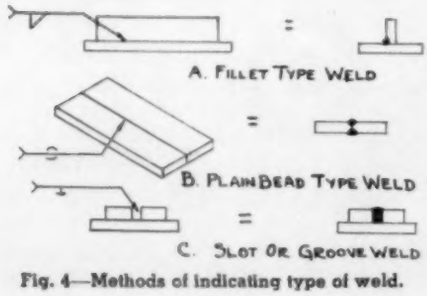


Fig. 4—Methods of indicating type of weld.

TYPE OF WELD—The method of showing type of a weld is illustrated in Fig.'s 4 and 5. A cross-sectional view of the weld is shown above or below the shaft line of the arrow, depending upon which side of the joint the weld is made. In the case of machined welds for butt joints, the depth and other specifications for the machined cut to be made are shown as dimensions on the cross-section view in the symbol. If the weld is to be flush with surface of plates and no higher (as in *b*—Fig. 5) the straight "flush" line indicates such a weld. If the designer should happen to want to grind the weld after completion, the symbol is included as a note with the "weld type" symbol.

SIZE OF WELD—The symbol indicating size of a weld is shown as a dimension in inches just before the "weld type" cross-sectional view, as shown in Fig. 6. Method of measuring size of a weld is illustrated in Fig. 7, which shows that length of shortest "leg" of a weld is the size of weld. The width across the top of a weld, or the depth of the throat are not stated in the measurement of most welds. Such dimensions appear in machined welds as specifications on the cross-sectional view showing type of weld. Figure 8 shows how much symbols simplify welding directions, compared to written directions.

POSITION IN WHICH WELDS ARE DEPOSITED AND NUMBER OF PASSES—Welds of all types may be made in almost any position, depending upon the plane in which the weld lies at the time the weld metal is deposited. The fact that welds may be classified as to the position in which they are deposited, and that a large number of studies of welds made in each of several common positions indicate that there is a constant difference in labor of application between each class, creates a basis for control in favor of the cheapest position.

Each of the positions most frequently encountered in welding, together with the symbol used in the R. G. LeTourneau organization to

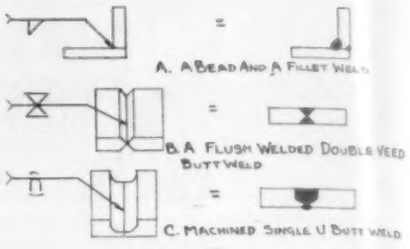


Fig. 5—Methods of indicating type of weld.

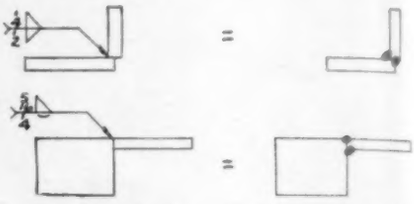


Fig. 6—How size of weld is indicated.

designate that position is listed below and is then illustrated in examples which follow:

	Position	Symbol Letter
1.	Flat	F
2.	Horizontal	H
3.	Semi-Vertical	SV
4.	Vertical	V
5.	Overhead	O
6.	Fillet	L

Figure 9 shows a ⅜-in. weld on each side of a member of a "T" joint. The letter *F* following the cross-sectional view of the weld indicates that the parts are rotated so that the weld metal is deposited down into a trough. If the plates were machined in such a way that the weld could be laid into a groove similar to the trough in Fig. 9, the symbol *F* would denote a positioned, or flat weld.

The number of layers of weld metal required to complete a weld of a given

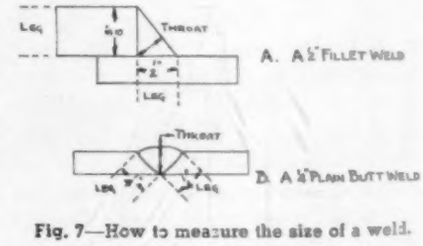
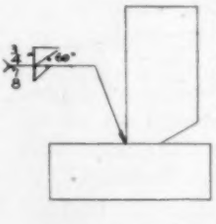


Fig. 7—How to measure the size of a weld.



A fillet weld extending 7/8 in. out from the juncture of the plates on the near side of the joint and a weld extending ¾ in. out from the juncture of the plates, one of which is bevelled on a 60 deg. angle, the surface of the weld being flush with the surface of the bevelled plate on the far side of the joint.

Fig. 8—Example of how symbols simplify welding directions to the shop man.

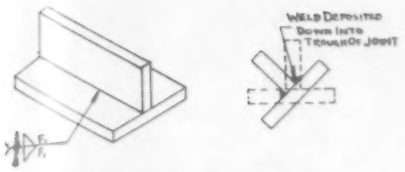


Fig. 9—Symbol for indicating fillet weld to be made in "flat" position.

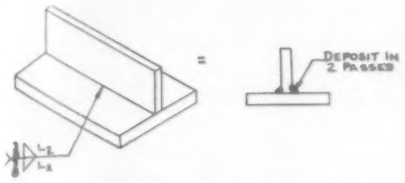


Fig. 10—Symbol to indicate two ⅜ in. fillet welds made in two passes each in "fillet" position.

size depends largely upon the position in which the weld is made. A ⅜-in. weld such as shown in Fig. 9, made in the flat position can usually be completed in one pass in the ordinary welding of our heavy machinery. If the weld is laid down in the "fillet" position, such as shown in Fig. 10, the ⅜-in. weld would require two passes in order to insure a sound weld, one leg of which extends a full ⅜ in. on each plate from the corner of the groove. The number of passes specified by the engineering department for the correct completion of the weld is shown by a small arabic numeral (a subscript) following the letter indicating the position in which the weld is deposited.

Welds made in the horizontal plane are indicated by a letter *H* as shown in Fig. 11.

The fusion of joints in the vertical plane may be done by building the weld up from the bottom, illustrated in Fig. 12, or from the top down, as shown in Fig. 13. The letter *V* indicates a vertical built up joint and *DV* signifies a joint welded from the top down.

Ordinarily welds in the vertical position, less than ⅜ in. in size, are welded from the top in our shop, because such welds can be deposited with a relatively large electrode, without greatly changing adjustment of the welding machine. Actually the cost of depositing a vertical weld from the bottom up in one or two passes is found to be almost exactly the same as making the same weld in several passes from the top down. The one built up from the bottom is usually more convex, but of slightly coarser grain structure, than the multiple down-pass weld which requires more time for cleaning, is

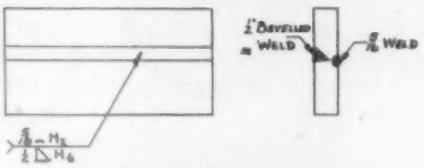


Fig. 11—Symbol to indicate that welds are to be made in "horizontal" plane. Near side in 6 passes—far side in 2 passes.

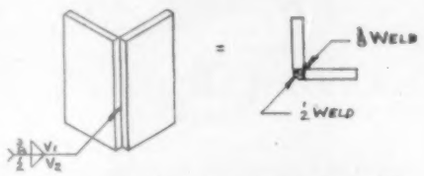


Fig. 12—Symbol for welding "vertical" joint by building up from the bottom.

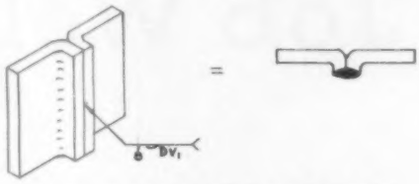


Fig. 13—Symbol for "vertical" joint to be welded from the top down.

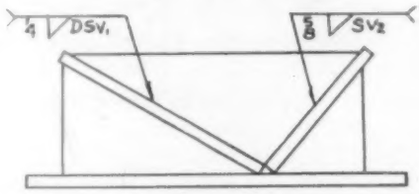


Fig. 14—Use of symbols for welding in the "semi-vertical" classification. "SV" means from bottom up—"DSV" means from top down.

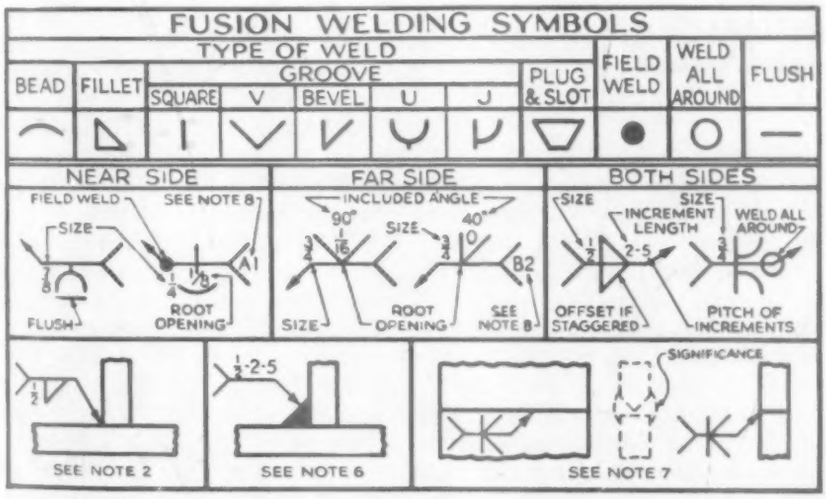
Fig. 15—Two ⅜-in. fillet welds made "overhead" in 4 passes each.

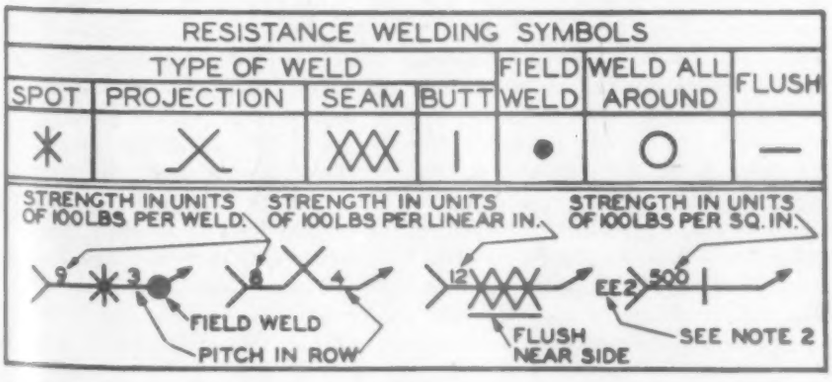
slightly concave, but of finer grain structure.

Welds which lie from 30 to 60 deg. away from the horizontal plane are considered semi-vertical welds. *SV* indicates a semi-vertical weld built from the bottom up, and *DSV* indicates a weld deposited from the top down. Figure 14 illustrates use of these symbols, showing both a "semi-vertical" and a "down-vertical" weld.

A joint fused by depositing weld metal on the lower side of the plates from underneath is said to be welded in the "overhead" position, which is designated by the letter *O*, illustrated in Fig. 15.

(Second installment of Mr. Brooking's article will appear in the September, 1939 issue.)





Suggestions for

building up

Job Welding Shop Profits

★ Opportunities for repair welding business are growing—With keener competition and overhead greater, advertising becomes a necessity—Proper equipment needed

By DAN E. RANDALL

Proprietor, Randall Welding Co., La Crosse, Wis.

ORGANIZATION AND OPERATION of a commercial job welding shop is no longer the "hit-or-miss" affair of a few years ago. Many factors have contributed to the necessity for a closely supervised, modern business structure. New competition, higher overhead and lower prices have made the job shop operator take in the slack at every available point. A growing consciousness on the part of the customer as to welding costs tends toward a cutting of the profit margin. Profits in the arc welding field should have a double meaning to the proprietor of a commercial shop.

Although each job must bear its share of material costs, overhead and profit, the customer's profit must also be given consideration. As a rule the customer knows the replacement cost of his repair. He expects a guarantee that the welded piece will be stronger than the original, and that welding will eliminate entirely any replacement delay. One would think this would be enough, but in addition to these items the customer also expects to make a profit. He estimates this profit usually at 50% and the job shop which does not show him at least a small margin on replacement cost, regardless of the repair, has certainly lost a customer.

In the infancy of this comparatively new industrial tool the welder could name his own price for a repair or fabrication job. This was limited only by cost of replacement and usually that was not a factor when loss of production was involved. Welding shops were usually located down some dark alley or carefully hidden in the corner of some obscure garage. Cost accounting was very crude. Today this branch of the welding industry presents a different picture. Most of the old time welders who had this golden goose by the neck are now working for the man who had the foresight to apply business principles to a modern business.

This new type of commercial welding or job shop has had many problems to meet. The first problem was to get the old shop out of the "hole in the wall" location and onto a prominent street where customers could find it without a search warrant. Competition became keener. Advertising for business became imperative. Overhead became greater and at the same time welding prices had to be scaled down to meet the new competition.

The majority of commercial or job shops operating today are two or three-man organizations. If they employ more, they usually have a kindred line such as a machine, garage or blacksmith shop. The straight welding job shop should carefully consider equipment needs. Auxiliary equipment is nice to have at times, but any piece of machinery which does not earn its way in a modern shop is a liability and should be ruthlessly eliminated. Equipment needs depend largely on geographical location, which in turn governs the type of repairs handled.

A job shop depending entirely on welding should have a portable d-c. welder of at least 300 amp. capacity for heavy outside welding and pipe thawing. At least half the business should come from this outside source. If it is a two-man shop an additional arc welder will be necessary. This can

either be an a-c. or d-c. machine of 200 amp. or more, or preferably another 200 amp. portable of the motor-generator type, which can be run from the power line in the shop or converted into a gas-driven machine for outside work.

Oxy-acetylene equipment is a necessity in a well-equipped job shop. This in turn calls for an acetylene generator in order to reduce gas costs to a minimum. Long-term contracts for oxygen, acetylene and carbide are profitable to the job shop operator providing he obtains the best price available.

Grinding Equipment

Grinding is a necessary adjunct to a welding shop. A large stand grinder that will take at least a 10-in. wheel is an absolute necessity. A good flexible-shaft grinder of ½ hp. or more, with various types of wheels for getting into the nearly inaccessible places is one of the best investments a job shop operator can make. It will pay for itself many times over by broadening the field of potential customers. A wire wheel on a power grinder will take the place of a sand blast machine, although compressed air is also a handy thing to have around a job shop and is inexpensive to install.

With the advent of the modern bus, the street car has been relegated to the junk heap and the air compressors on these old cars are just the thing for a welding shop installation. Small tools are of course essential as well as a small electric drill with a chuck for a grinding wheel. This will prove invaluable on outside jobs, such as cracked furnace sections, etc. The profit in welding is governed to a large extent by the equipment used. Both speed and good workmanship are essential—but a minimum of investment must also be considered if you wish to stay on the profit side of the balance sheet.

Every person who has a broken metal part, no matter how small, is a potential customer of a welding shop. The baby's perambulator, the kiddies' tricycles, the boys' and girls' bicycles, big brother's "tin lizzie," dad's tools and mother's cooking utensils are all susceptible to breakage and help to boost the job shop operator's income. However, a job shop depending solely upon welding for its revenue must sell its services to a broader field. The farmer is now a large user of welding and can become a greater customer providing he is properly educated. Road contractors are the shop owner's best source of income if he has made himself a master of hard-surfacing technique and knows how to sell it. Cement plants, stone crushing and lime pulverizing equipment operators welcome the efficient welder with wide open arms.

Reclamation of castings for cast-iron and brass foundries is one type of business which is easily sold. Laundries and machine shops are real sources of welding jobs. So also are the stores handling home appliances of various kinds. Pipe and structural welding on new buildings, as well as contract welding, should not be overlooked. The wide-awake shop owner will contact all these sources through the best possible medium and endeavor through courteous service and good workmanship to build up a steady business that will return a worthwhile profit to himself and to his customers.

What Type of Advertising?

In the early days of the job welder advertising was unthought of, and even today it must be handled properly. The advertising budget of the average job shop is of necessity quite small. Consequently, every dollar spent should be made to do its fully duty by way of a profitable return. The shop owner is constantly beset with one advertising scheme or charity racket after another and he must learn how to say, "no" emphatically, or he will be working for someone else most of the time. Every form of business uses the medium of advertising which will reach the potential customer most economically and effectively. Certain of the services offered by a job shop are seasonal and these must be called to attention of customers at the opportune moment.

Personal contacts are always the best form of advertising for the job welding shop. Personal contact allows the welder to look over his customers' needs with the eye of an expert and suggest welding applications that will not only save his customer money, but increase his own profit. It is obvious, however, that the shop owner cannot call personally on all of his potential customers. He should confine this form of advertising to the large accounts such as road contractors, building contractors and industries of various kinds. To reach the rank and file of welding users in the city, his best medium is the classified section of his local telephone directory. The space he buys will, of course, be governed by his advertising budget. In this space he can list some of the welding services he has to offer the public.

It is a well known fact that a customer will turn to the classified section when he desires some specific service. This type of advertising is the most economical way of reaching rural as well as urban customers. Usually there are a number of small exchanges covering the rural sections and space in these small directories is very reasonable. The advertisement is there every day throughout the year and the farmer really knows his telephone directory.

Seasonal work such as pipe thawing or repairs to agricultural implements can be handled in two ways. Direct mail letters to the farmers can cover these and a multitude of other services. The cost is small if they are mailed to rural box holders, and any postmaster will give the details for the territory he serves. The classified section of the daily paper is a good medium if you are offering a special service which will interest only the city dweller. Every job welding shop must advertise in some manner in order to prosper. Success depends largely upon selection of the proper advertising media.

Survey Your Territory

The job shop owner should extend his services to cover every branch of welding that he can reach with standard shop equipment. He must look around his territory and take stock of the welding needs his customers are unable to meet (even with their own welding equipment), because of lack of experience or improper equipment. There are any number of these, depending upon geographic location of the shop. Hard-surfacing is a universal application and one that an inexperienced operator should not attempt. This is a broad field and a job shop can build up a reputation for hard-surfacing that will bring this type of work to his shop from miles beyond his "natural market area."

Welding of manganese steels is another type of repair the amateur will stay away from if he is wise. The experienced operator should have no trouble, however, if he posts himself on the proper technique and applies good common sense. Nearly every community has a rock crushing plant

of some kind and the building up of crusher plates with applicator bars is profitable both to the customer and to the welder.

Rebuilding of plow lays and cultivator shovels is a highly successful operation and one that gives extreme satisfaction to the farmer, once you have sold him on the idea. The margin of profit on this work is small, but the volume, once you have sold the process to your customers, will adequately compensate you. Arc cutting or flame-cutting of scrap iron, or cutting of scrap hot water heating tanks for water or feed troughs or flower beds is another form of profit building. Your local junk dealer will be glad to know that you can cut boilers and other scrap materials cheaper than he can do so.

How to Do Arc Cutting

The arc cutting process requires a 300 to 400 amp. machine. Use a reverse-polarity rod and soak the coating in a bucket of water. Adjust your machine for straight polarity and use this water-soaked reverse-polarity rod as a cutting (melting) instrument. You will be surprised at its speed and in a short time you should be able to do a creditable looking job.

Feed hammer mills are used throughout the country, and the building up and hard-surfacing of the corners of these hammers is a profitable application for both the customer and the job shop. Many districts have limestone deposits and the pulverizing of this lime rock has become a sizeable industry in some areas. The manganese hammers in these mills wear rapidly and are expensive to replace. They can be built up and hard-surfaced at about half the cost of new ones, and this is a repeat business which is quite profitable.

Pipe thawing, while not a dependable source of revenue, is extremely profitable. It is necessary first to learn how to do the job correctly, then to keep your public acquainted with the fact that you are in a position to give them this type of service on an emergency basis. There are many other kinds of specialized services you can offer. Hard-facing of silo filler and corn shredder knives is one of them. Although the "going" is getting tougher for the commercial job shop, there are still profits to be made and profits to be saved for your customers if you conduct your business in a business-like manner.

Railway Saves Money By Fabricating On the Job

By T. H. GARDNER*

★ It developed that a saving of approximately 15% would be effected by doing our own fabrication, after writing off the loss in dismantling the plant. Another attractive feature was that the work would all be done at one location. Our railway has in the past done considerable arc welding on bridge structures, both on new structures and reinforcing of existing bridges. The writer personally shop inspected practically all of the welded fabrication which had been contracted for by the Florida East Coast.

An added reason for setting up our own fabricating shop was our desire to use pile cutoffs for certain structural details. Further, by having the work done under our supervision, we were able to obtain better control of progress and quality of work.

About 10 tons of light beams and stanchions were ordered for erection of the fabricating shed. The entire lot of steel was delivered at one time. We had three short stub tracks available, two of which had been connected to old dock trestles. A 29 ft. deck girder span which had been removed by the contractor when the test piles were driven, was available. The laterals were removed, the girders were spliced together into a 58 ft. overhead gantry over three tracks. A light tower of angles was built and placed on a push car for erection.

Welded Fabricating Shed

Six-inch stanchions were used in making the continuous welded frames for the shed. Four-inch 'I' beams (continuous) were used for purlins. The rigid frame centers were 16 ft. 6 in. Stud columns were inserted supporting a crane runway of 90 lb., 33 ft. rails, the rail serving as a beam and also as the crane rail. Intermediate supports were put under the rail cutting the span to 8 ft. 3 in. The shed was 132 ft. long and 20 ft. wide and was set over the track. The crane runway extended clear through the shed and under the gantry a distance of 200 ft.

The net cost of constructing and later removing this temporary shed, four gantries and crane runway, track changes and trestle extensions, extending power lines and installation of equipment, totaled $5,500. The cost together with current expenses such as water and lights amounted to an overhead of approximately 15% of the cost of fabrication performed. The only work which was not performed in this field shop was machining of pedestals. These weighed 200 lbs. each, and were faced off top and bottom.

Net cost of unloading, cutting, fitting and fabricating girders and pedestals was $30.00 per ton, a saving of $12.00 per ton under the lowest bid received.

It is believed that within a few years, this type of work will be commonplace.

*Structural Engineer, Florida East Coast Ry., St. Augustine, Fla. This is the final installment of Mr. Gardner's paper. First section was published in the July, 1939 issue, pages 21-22. This was one of the prize-winning papers in the $200,000 award program of the James F. Lincoln Arc Welding Foundation.

Table 1—Costs of Shop Welding

Part	Electrode	Labor	Power	Machine rental	Total	Unit cost per ft.
W. I. sleeves						
¼ f. 8,400 lin. ft.	$163.20	$537.60	$126.00	$184.00	$1,010.80	$ .144
Pedestals and girders						
¼ f. 5,000 lin. ft.	97.20	322.00	97.00	100.00	616.00	.148
⅜ f. 4,200 lin. ft.	176.40	502.40	126.00	184.00	988.80	.282
Piles						
⅜ f. 6,000 lin. ft.	260.00	708.00	186.00	250.00	1,404.00	.281
½ f. 3,600 lin. ft.	314.00	820.00	216.00	300.00	1,650.00	.55
Total 27,200 lin. ft.					$5,669.80	

Twenty per cent overhead was added to arrive at total cost.
Average cost of welding was $0.25 per ft.

With proper organization, any railway or industrial plant can do this class of work with a saving in first cost and in maintenance. One of the greatest benefits of welding is the ability to put metal where it is needed. Connections are reduced in size and eccentric connections, and connections with secondary stresses can be avoided.

A structure such as this welded bridge trestle is free from open joints which invite corrosion. A check-up on a former welded structure we built, indicated that the welded structure could be completely painted at less labor cost than the cost of painting the rivet heads alone in the riveted structure which it replaced.

We believe that the cost of this structure was about one third less than any other type of permanent construction yet developed. The railways of this country spend millions of dollars every year in new bridge construction. But the use of arc welding in bridge construction is in its infancy. Some structural engineers still question its value. However, there have been numerous demonstrations of its ability to withstand impact stresses and fatigue.

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Welded Engine Base Proves To Be Better Than Cast-Iron

By L. O. RICHARDS*

★ The business of manufacturing equipment for coal mine use naturally leads to a search for more pool-proof and rugged machine design. Because of a rather short season of peak coal production, mine delays of any kind during this period are extremely expensive. Every piece of mine equipment which has been in service for more than a few years is operated beyond its rated capacity during peak productions. Hence the value of machine parts having many times the strength of the metals originally used in them and yet occupying the same space, can be readily appreciated. For many years we have been taking increasing advantage of the greater strength, lighter weight, and production economy available in machinery manufacture through the use of electric welding.

In the beginning, deviations from conventional design and construction was confined to small items which were not expensive in themselves, but whose failure in service might mean many hours of lost time in replacement. As time went on it became apparent that these parts fabricated from welded design were not only much more durable and rugged, but in case of breakage could be repaired in a fraction of the time required for cast-iron equipment. Thus the change-over in design enveloped practically all basic pieces of mine equipment.

However, the one item which has stood fast through this change-over is the first motion steam mine hoist with its large pair of bed plates or main frames where great weight is an important and advantageous feature, but where many points are thrown in tension, which reduces the effectiveness of cast iron. Failures of these frames therefore are not infrequent, due to tensile stresses at the above-mentioned points, as well as to continuous stress reversals at other points, not to mention the abnormal strains and shocks imposed because of overloads and wrecks.

Having been called upon to recommend replacement of a broken frame of this type last spring, we turned to arc welded construction as the solution. Inasmuch as we operate both a grey iron foundry and a structural shop, our recommendation was entirely unbiased; and both types of construction, i.e., casting versus welded steel, were debated thoroughly on their respective merits.

Rolled Steel Is Stronger

Rolled plate steel, lacking the brittleness of cast iron and possessing between four to six times as much tensile strength, with approximately two and one-half times the rigidity, was ideally suited to the conditions. Then, too, in the event of a wreck, any needed repairs could be more readily effected by re-welding or additional welding with small shut-down time as compared to patching up mechanically a broken cast-iron bed plate.

Our first step in changing this base over to welded steel construction was a study of the duty to be performed by the hoist and an analysis of the weaknesses of the old iron bed. The hoist duty consists of a total gross load of 22,500 lbs. to be lifted from a mine depth of 470 ft. This operation or cycle has to be maintained on an average of 220 times an hour for seven hours, with a rest period of two seconds between each hoist.

As a matter of interest, the two cylinders of this hoist are 28 in. bore by 42 in. stroke, operating on 150 psi. steam pressure. The rope winding drum is cylindro-conical or "quick step up" type, being 8 ft. in diameter on the small end and 11 ft. in diameter on the large portion. For the quick handling required of so large a hoist, a steam actuated reversing mechanism is used.

Inasmuch as the pull of these engine

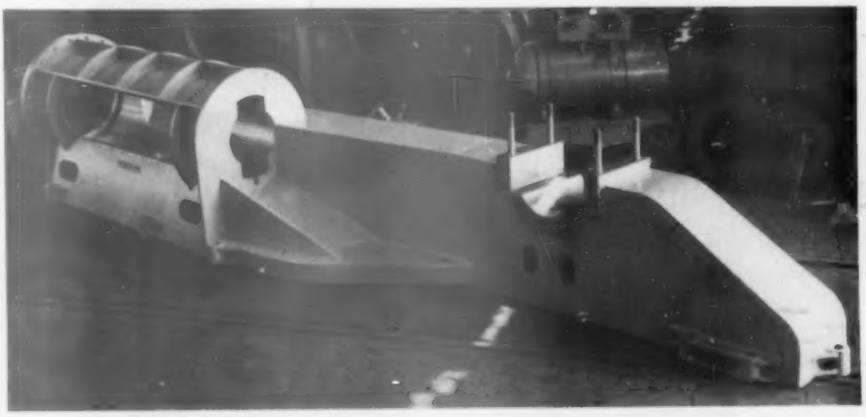

Fig. 1—Welded engine base is fabricated of several pieces of flame-cut plates. Stresses were relieved as welding progressed by use of an air hammer on the "hot" weld metal.

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frames is upward at about 45 deg., excess weight is an advantage in counteracting strains on the foundation bolts; therefore, any idea of a great weight reduction over the old castings was discarded, this despite the fact that from past experience we knew that the weight could have been reduced some 30% without dropping below safe limits as to strength. The finished frames in welded steel weighed four tons each, as compared to five tons for the cast-iron beds; and it should be remembered that some 24 sq. ft. of bearing area was added to the new frames to give better foundation anchorage.

Being the first welded engine bases of this type, every precaution was taken to make certain they would turn out to be a clean smooth job and stand up under operation. Appearance was especially important because of the natural tendency of the operators to compare them with the old castings upon which considerable finish and paint were lavished.

Having successfully used Fleetweld electrodes for a number of years, they were chosen for this job. Lincoln arc welders were used and Lincoln engineers checked our designs and offered numerous helpful suggestions as to procedure.

Flame-Cut Shapes

The construction of these engine bases can be seen clearly in Fig. 1. From a study of the picture it will be clear that the welded base is made from a considerable number of pieces of steel plates, flame cut to proper size and shape. These parts were then fused together into a single structure by the electric arc.

The facility of plate fabrication is demonstrated particularly in the arrangement for anchoring this base to the foundation by means of the holding-down bolts. Note the holding-down attachments at the bottom of the bed. These are simply pieces of shafting drilled for bolt holes with plate brackets welding them to the base.

The cost of this arc welded base was approximately the same as that of the cast base if the comparison is made on the assumption that the pattern was available for the casting. If, however, the cost of the pattern equipment is considered, then the cost in cast-iron would have been practically double that of arc welded construction.

Fitting up and welding proceeded without a single "hitch"; in fact, we encountered less difficulty, both in fabrication and machinery, than with cast iron. With the former cast construction we always had trouble in lining up for machining, due to shrinkage strains and warpage. Stresses were relieved as the welding advanced by the use of an air-driven calking hammer on the hot weld. The finished unit came out in almost perfect alignment with our layout of desired dimensions. Inasmuch as these bed plates were about 20 ft. long and about 450 lbs. of rods were used on each unit, we felt that our welders had done very well.

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Welding Versus Prejudice

By J. F. LINCOLN*

★ The welding industry is suffering from too many parents. Each parent wants to make the rules of conduct. The difficulty is that no two parents agree on how to raise the child. Many people are attempting to make standards for welding without sufficient knowledge of the facts. Many people also are sure of a great many facts about the subject, the only difficulty being that these facts are just not so.

That welding has lived through its childhood under these conditions and grown to manhood is remarkable and shows how strong is its constitution. Welding must have parents, but there should not be so much doubt thrown on its paternity. Standards of conduct are necessary but they must be founded on fact and need.

There is no doubt that a great deal of the work which has been done to perfect and test welding, has been helpful. It is necessary however, that any standards be founded on fact rather than fiction. The following facts learned from experience are true:

1. The shielded arc deposited metal is definitely stronger than mild steel plate under all conditions.

2. The shielded arc weld metal is a good deal more homogeneous than mild steel plate, hence less apt to have defects.

3. The making of a weld with the shielded arc requires little skill, particularly in the downhand position. The chance of that weld metal being as good as the parent metal is tremendously better than the chance of the parent metal being as good as the weld.

In spite of these facts we still have any number of people in positions of authority who insist on limitations, which are neither necessary nor intelligent. For instance, the Interstate Commerce Commission insists that to weld a tank car which carries liquids at no pressure, is dangerous. The fact that the tanks into which the oil goes from these tank cars must be welded to remove chance of leakage, does not affect them. The further fact that this oil was distilled at a pressure of over 1000 psi. at over 1000 deg. F., in an arc welded vessel, disturbs them not at all.

The Interstate Commerce Commission still insists that a locomotive boiler cannot be welded, although the loco-

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Table A—All-Weld-Metal Tension Specimens Made By Welding Students After Limited Training Periods

	1st Week		2nd Week		4th Week	
Student Groups	Tensile Strength (psi.)	% Elongation	Tensile Strength (psi.)	% Elongation	Tensile Strength (psi.)	% Elongation
First group of 14 students in A.M. class (averages)....	66,350	19.7	65,185	23.6	65,557	28.4
First group of 14 students in P.M. class (averages)....	66,100	27.2	66,264	30.0	63,392	32.2
Second group of 13 students in A.M. class (averages)....	66,821	23.9	65,185	23.6	63,515	27.0
Second group of 16 students in P.M. class (averages)....	65,144	31.7	66,264	30.0	63,400	29.6

motive super-heater which carries the same steam pressure at a higher temperature in the same boiler, must be welded.

The statement is often made that welding is all right provided the man who does the work is sufficiently skilled and careful. In many cases the operator must be tested every few months, or even days, in order to satisfy the inspector. It is doubtful if this is necessary. It is probably a good deal more difficult to make a weld, which is worse than the parent metal, than it is to make one which is better. With proper electrode, proper size and type of welding machine, and proper supervision by the foreman, it is a practical impossibility for any weld to be made which will not be better and more reliable than the metal itself. This is information which many people will question. In order to determine the facts in connection with this matter the following test was made:

Test of Welding Students

Fourteen men in a recent class of the welding school of The Lincoln Electric Co. who never had any welding experience whatsoever, were selected for test purposes. (These men were followed by a second group two weeks later for the same test.)

Plates to be welded were properly prepared. The welding machine was properly set and the proper size of electrode was given to the operator. He was given 15 min. instruction in holding the arc. He then proceeded to make a standard test sample of all deposited metal of ½ in. diameter and a length of something more than 2 in.. with two ends arranged for clamping in a standard tension machine. At the end of two weeks he made another sample in exactly the same way, and at the end of his course, i.e., four weeks, he made the third sample. The results given in Table A speak for themselves:

The following conclusions can be drawn from these facts:

1. These welds made by novices who had never had any experience before would have withstood all commercial requirements.

2. A very wide variation occurs in these tests. These are caused largely by the impurities in the plate being carried over into the deposited metal, not by difference in skill.

3. The weld metal is under all conditions better than the parent plate.

We can be assured from these tests that there is no reason for many of the tests now required. With proper type and setting of machines, proper size of electrodes and proper visual inspection of the weld after completion, satisfactory welding can be done regardless of training of the operator. If other investigation or testing is to be done to assure the reliability of any welded structure, the plate material should be the thing examined more than the weld.

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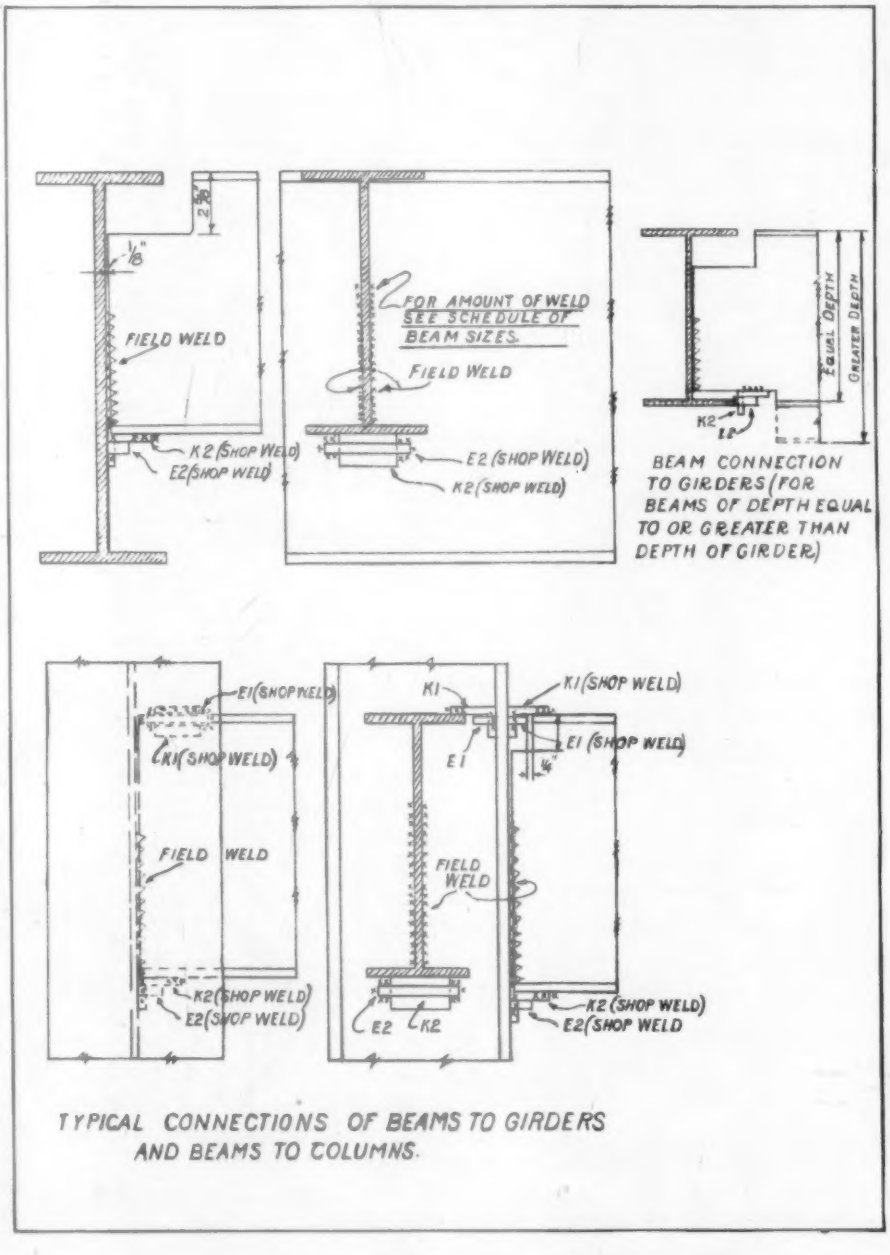
Direct Web Welded Connections

By VAN RENSSELAER P. SAXE*

★ Accompanying data tables and sketches show design values for a direct web-connected beam weld, together with illustrations of how the weld is applied to different types of connections, such as beams to girders and beams to columns. There is also included a typical column splice condition and wall bearing end of a beam, together with a section which shows just how the weld is applied to the web of the beam to join it to the support.

*Consulting Engineer, Baltimore, Md. Mr. Saxe is the author of the article "Welded Steel Buildings," which was published in the May, 1939 (pages 24-27) and June, 1939 (pages 26-27) issues.



TYPICAL CONNECTIONS OF BEAMS TO GIRDERS AND BEAMS TO COLUMNS.

This section shows the maximum amount that the beam web can be away from the supporting member and still make a good weld.

Enough information is contained in this small amount of data to make it possible for anyone with any degree of engineering ability and knowledge of welding to design and erect any welded steel frame in which it is not necessary to figure wind stresses. Buildings subject to such stress require more welding than is shown for these connections, because to resist sway it is necessary to place additional welding on the top and bottom flanges of beams to enable them to develop greater stiffness to resist swaying.

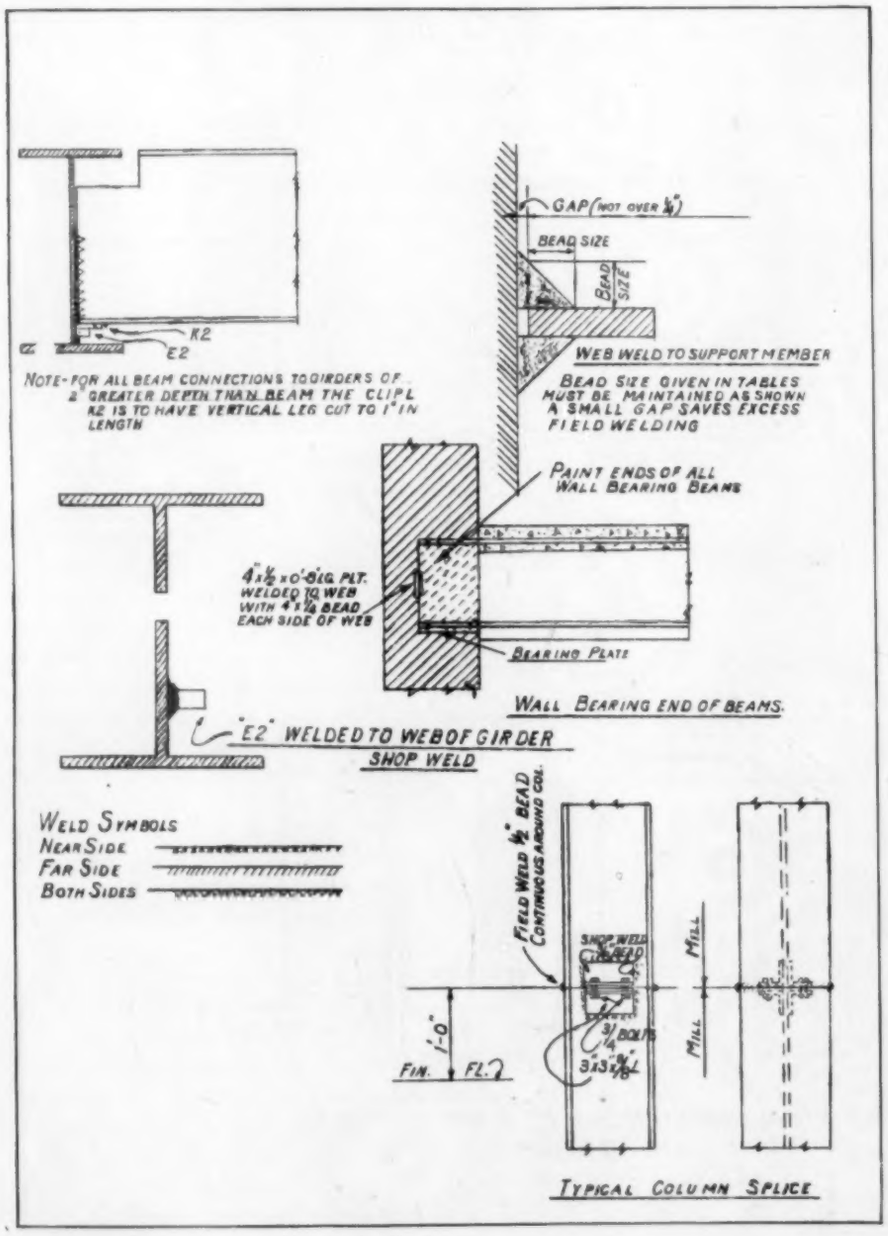
Connections of the type to withstand wind stresses get into more detailed engineering design and if they are shown at all should be the subject of special discussion.

The same condition exists in design of riveted structures when wind bracing is required. The standard connections shown in the steel handbooks cannot be used in such cases, but connections have to be designed for the special conditions required. In this type of connection the welded design affords an even greater saving than in the so-called simple beam design.

The beam designation "33 W F 240" means what we call a 33 in. deep wide-flange steel beam weighing 240 lbs. per lineal ft. Where the I is used, this indicates the old standard I beam which has almost gone out of use because of the greater economy of the wide-flange beam. All of these beams are found in the standard handbooks.

Connections, in which the beam webs are welded directly to the supporting columns and girders, have been designed to cover the range of standard riveted connections as given in the 2nd edition of the A.I.S.C. handbook, Manual of Steel Construction. See the Table of Connections.

In addition to the direct weld, the connections utilize top and bottom erection seats, top clip angles and seat angles. These are for erection purposes only and have in no way been included in the values of the connections. Details of connections and notes are given in the sketches.


GAP (NOT OVER 1/4")
BEAD SIZE
BEAD SIZE
WEB WELD TO SUPPORT MEMBER
BEAD SIZE GIVEN IN TABLES MUST BE MAINTAINED AS SHOWN A SMALL GAP SAVES EXCESS FIELD WELDING
K2
E2
NOTE-FOR ALL BEAM CONNECTIONS TO GIRDERS OF 2" GREATER DEPTH THAN BEAM THE CLIP L K2 IS TO HAVE VERTICAL LEG CUT TO 1" IN LENGTH
PAINT ENDS OF ALL WALL BEARING BEAMS
4"x1/2"x0'-8" LG. PLT. WELDED TO WEB WITH 4"x1/4" BEAD EACH SIDE OF WEB
BEARING PLATE
WALL BEARING END OF BEAMS.
"E2" WELDED TO WEB OF GIRDER
SHOP WELD
WELD SYMBOLS
NEAR SIDE
FAR SIDE
BOTH SIDES
FIELD WELD 1/4" BEAD CONTINUOUS AROUND COL.
SHOP WELD
MILL
MILL
1'-0"
FIN.
FL.
TYPICAL COLUMN SPLICE

Short and Heavy Welds

In the design of the connections, the welds have been made relatively short and heavy. They do not exceed two-thirds of the beam depth in length and the beads are not less than four-fifths of the web thickness. The use of short heavy welds has the effect of forcing any deformation to take place in the web of the beam, and keeping the weld stress within the yield point stress. The above mentioned limitations of length and bead of welds should be used in the design of all connections of this type.

The strength of the connection is dependent upon two factors, the value of weld and the value of the beam web. The value of the weld is the product of the length of weld in inches times the allowable weld stress per lineal inch.

Calculating Weld Strength

Consider the weld metal as being in contact with a strip of the web of the beam, of length equal to the weld length and of area equal to the weld bead times the web thickness. The remaining part of the beam web shears along the edge of the strip, rests on top of and pulls on the bottom of the strip. The stress along the edge of the strip is taken at 12,000 psi. The stress at the top and bottom of the strip is taken at 24,000 psi. These values for each beam are listed in the fifth and sixth columns of the Table of Connections. The value of the beam web is the product of the figure in the sixth column times the weld length, plus the figure in the fifth column.

The Table of Connections lists the following information:

Table of Connections

Col. 1—Beam sizes in order of depth and weight.

Col. 2—Length and bead of weld on each side of web, in inches.

Col. 3—Connection values, in kips. (1,000 lbs.).

Col. 4—Min. span of uniformly loaded beam for the connection, in feet.

Col. 5—2 times the weld bead times web thickness times 24,000, in kips.

Col. 6—Allowable web shear, in pounds per lineal inch.

Figures in the fifth and sixth columns of the table may be used to advantage in computing connections of values other than those of the standard connection equivalents.

Example: Assume 201,100 with reaction of 155 kips. Weld — ¾ in. bead.

155,000 ÷ (2 × 6000) = 12.9 in. required for weld value. Say 13 in.

155,000 — 31,400 = 123,600. 123,600 ÷ 10,470 = 11.8 in. required for web value. Use ¾ × 13 weld on each side of beam web.

Value of weld = 2 × 6000 × 13 = 156,000 lbs. = 156 kips.

Value of web = (10470 × 13) + 31,400 = 167,400 lbs. = 167 kips.

Connection value = 156 kips.

» «

Simplified Designs Using Standard Structural Shapes

By F. J. WILHELM*

★ In the steel fabricating business we recive many blue prints from prospective customers and from our own experience with the designs on these blue prints, we cannot help but notice a serious deficiency in the knowledge of fundamental principles of welded fabrication. For one thing, designers do not seem to appreciate the necessity of properly fitting two pieces together before attempting to weld them. Too often a poor fit-up produces a poor weld. In my opinion, good clean cuts can be made using a power shears, friction saw or flame-cutting equipment. Good joint preparation will save the fabricator time and money. This saving is naturally passed on to the customer. The illustrations which follow present several good examples of welded machinery fabrication, utilizing standard structural sections.

*The Dayton Fabricated Steel Co., Dayton, Ohio.

Additional Tables of Connections as prepared by Mr. Saxe will be found on pages 32 and 35.

VAN R. P. SAXE

TABLE OF CONNECTIONS B2

BEAM SIZE	WELD EACH SIDE OF WEB	CONN. VALUE IN KIPS	MIN. SPAN FOR SHEAR IN FT.	WELD WEB 48000	ALLOW. WEB SHEAR PER LIN. IN.	BEAM SIZE	WELD EACH SIDE OF WEB	CONN. VALUE IN KIPS	MIN. SPAN FOR SHEAR IN. FT.	WELD WEB 48000	ALLOW. WEB SHEAR PER LIN. IN.
36WF300	¾×14	168	39.4	34.1	11,330	27WF106	½×14	103	16.2	12.8	6,420
280	×14	168	36.8	31.8	10.620	98	×14	96.1	16.0	12.0	6,000
260	×14	168	33.9	30.4	10,130	91	×14	92.8	15.1	11.6	5,790
250	×14	166	32.9	29.4	9,790						
240	⅝×17	170	30.8	23.7	9,490	24WF160	⅝×10	98.4	25.2	19.6	7,870
230	×17	170	29.5	22.9	9,190	150	½×13	104	22.2	15.0	7,540
194	×17	170	23.4	23.1	9,250	140	×12	96.0	22.4	14.2	7,130
182	×17	170	21.9	21.8	8,710	130	×12	94.9	20.9	13.5	6,780
170	×18	167	20.8	20.4	8,160	120	×12	93.3	19.3	13.3	6,670
160	×19	168	19.3	19.6	7,840	110	×12	85.6	19.3	12.2	6,120
150	½×21	168	17.9	15.0	7,500	100	⅜×13	78.0	19.2	8.4	5,610
						94	½×12	86.5	15.3	12.3	6,190
33WF240	¾×13	156	31.2	29.9	9,960	87	⅜×13	78.0	15.7	8.6	5,760
220	⅝×15	150	29.6	23.2	9,300	80	×12	72.0	15.5	8.2	5,460
210	×15	150	28.2	22.4	8,980	74	×12	69.6	14.8	7.7	5,160
200	×15	150	26.8	21.4	8,580						
152	½×19	152	19.2	15.2	7,620	21WF142	⅝×9	90.0	21.2	19.7	7,910
141	×18	144	18.6	14.5	7,260	132	½×11	88.0	20.2	14.7	7,370
132	×18	139	17.9	13.9	6,960	122	×10	80.0	20.4	13.6	6,810
125	×18	137	16.9	13.7	6,840	112	×9	69.5	21.6	12.6	6,330
						103	×10	80.0	16.0	14.5	7,300
30WF210	⅝×13	130	30.0	23.2	9,300	96	×10	80.0	14.8	13.7	6,900
200	×13	130	28.4	22.2	8,890	89	×9	70.9	15.5	12.9	6,450
190	×13	130	27.0	21.3	8,520	82	×9	65.8	15.4	11.9	5,990
180	×14	133	25.1	20.1	8,040	73	⅜×11	66.0	13.7	8.2	5,460
172	×14	130	24.4	19.6	7,860	68	×10	59.3	14.2	7.7	5,160
132	½×17	136	16.8	14.7	7,390	63	×10	56.6	13.6	7.4	4,920
124	×16	126	16.9	14.0	7,030	59	×10	53.8	13.4	7.0	4,680
116	×16	122	16.2	13.5	6,770						
108	×16	118	15.2	13.1	6,570	18WF124	⅝×7	70.0	20.6	19.5	7,810
						114	½×8	64.0	20.6	14.2	7,140
27WF177	⅝×12	120	24.6	21.8	8,710	105	×8	64.0	19.0	13.3	6,650
163	×12	117	23.2	20.1	8,040	96	×7	55.3	20.1	12.3	6,150
154	½×15	120	21.4	15.2	7,620	85	×7	56.0	16.8	12.6	6,310
145	×14	112	21.6	14.4	7,200	77	⅜×9	54.0	15.8	8.5	5,700
114	×14	109	16.5	13.7	6,840	70	×8	48.0	16.0	7.9	5,250

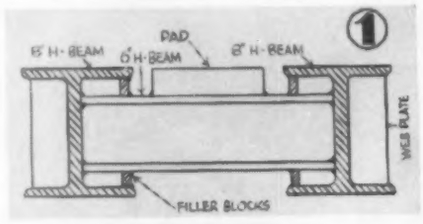


Fig. 1—Cross section of machine base using 10 in. by 10 in. H beams for rails and 8 in. by 8 in. H beams for cross-members.

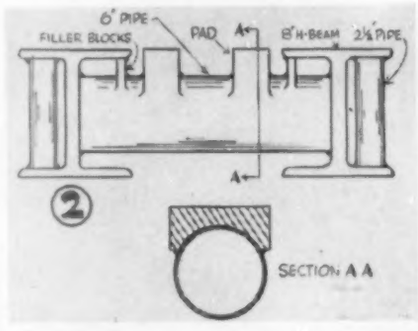


Fig. 2—A similar type of machine base, using pipe for cross-members and also for spreaders. Mounting pads can be made to meet any height requirements.

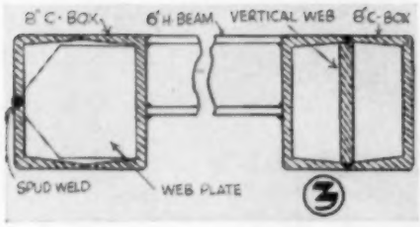


Fig. 3—Box type of channel frame, which is easily fabricated and very rigid.

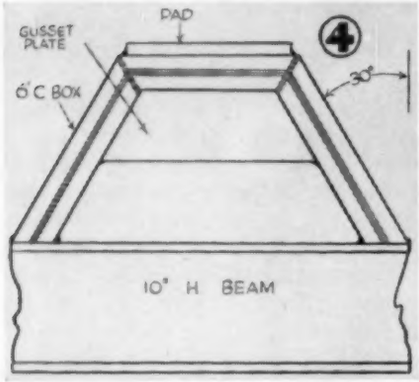


Fig. 4—Simple type of bridge or saddle fabricated of box channels.

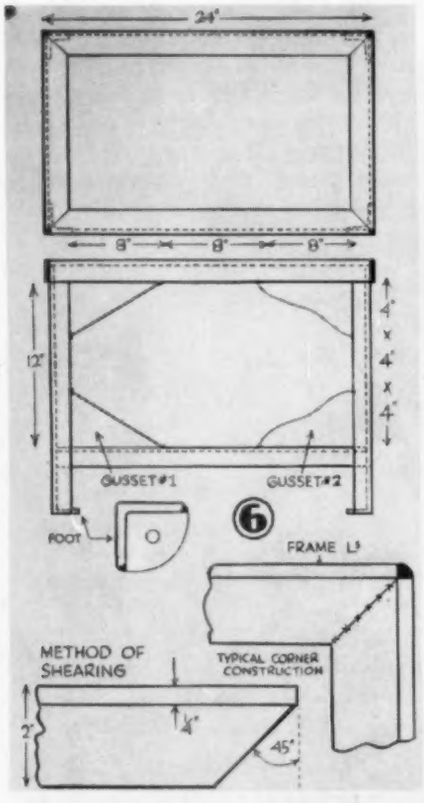


Fig. 6—Simple angle-iron construction, such as used for shop trucks, stands.

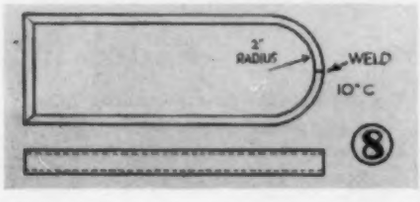


Fig. 8—Channels and I beams can be bent better when cold than hot, using either a press or bulldozer. The operation must be done progressively until the desired radius is obtained. If the bend is of small radius, the job can be done more quickly by making the frame in two pieces and welding them together.

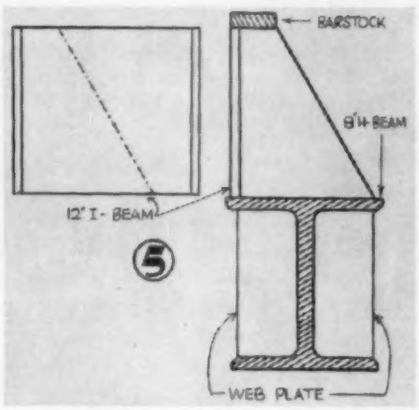


Fig. 5—Large I beams or H beams can be cut diagonally as shown by dotted line, making two uprights. This procedure saves making two vertical welds.

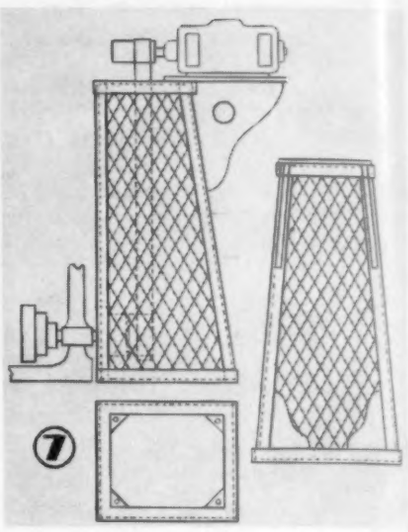


Fig. 7—Type of construction which can be used for combination belt guards and motor mountings.

Welded Steel Pipe Can Take Severe Punishment

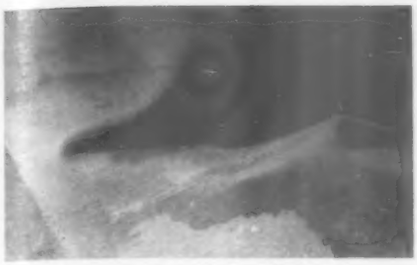
This arc welded 84-in. steel water pipe was crumpled severely after its supports were washed away. Welded joints did not fail.

★ Steel pipe, arc welded, can certainly "take it." This was demonstrated recently in Colorado when a 60-ft. span of water-filled 84-in. arc welded pipe was left hanging in mid-air for a considerable time and then toppled to the ground when a concrete support at one end gave way. The pipe was crumpled right across the welded joint without cracking the weld.

Santa Maria Reservoir, located on North Clear Creek, about 30 miles up the Rio Grande River out of Creede, Colo., stores water in the winter and early spring for irrigation use in the San Luis Valley. A pipe line 8100 ft. long diverts water out of North Clear Creek. From the outlet end of this pipeline a canal 1¾ miles long carries the water the rest of the way to the reservoir.

The 8100 ft. of pipe in this system was originally wood stave. Maintenance on it was high after the first five years of its life. By 1934, after it had been in service 20 years, it had reached the end of its useful life. Maintenance costs by that time made its continued use impractical. The fact that the steel bands were in excellent condition indicated that a steel pipeline would give exceptionally long maintenance-free life.

In 1934, the Thompson Mfg. Co., Denver, Colo., entered into a contract to replace the 8100 ft. of wood stave pipe with a welded steel pipeline 84 in. in diameter. Adjacent to the diversion dam, 700 ft. of this new pipe was of ¼-in. wall supported above the ground



Close-up of crumpled pipe in vicinity of a welded joint.

by stiffener rings on low concrete piers set on 30-ft. centers. The balance of the line was of 5/16- and 3/8-in. wall and was buried. The maximum working pressure was approximately 175 ft. head. It required over nine miles of electrically welded seam to join the plates together in the fabrication and installation of this pipeline. Welding was done by the shielded arc process with equipment supplied by The Lincoln Electric Co.

Given Cold Water Test

The outlet end of the pipe was bulkheaded with a steel bulkhead and the pipe was filled with water and tested for leakage in November, 1934. The temperature of the test water was just above the freezing point. This is significant because very cold water will leak from a pipeline where water at normal temperatures will not. Notwithstanding the coldness of the test water, there was absolutely no loss of water through leakage in the nine miles of welded seam during the 24-hr. test. With other types of pipe it is recognized that there will be leakage, and a leakage factor is set up.

During the winter, the flow in North Clear Creek is very low, amounting to only 12 or 15 cu. ft. per sec., and this, in the early part of the winter, is mostly slush ice. Just before the washout, the pipeline was carrying 12 or 15 cu. ft. per sec. of this water and slush ice. Due to negligence on the ditch-rider's part, the slush ice was allowed to pile up and freeze in the concrete outlet structure of the pipeline until it formed an ice dam in the concrete outlet structure. The ice dam finally built itself so high that water could not go down the canal and was forced to overflow the concrete structure and run down the hill along the pipeline. This water finally washed out a hole 24 ft. deep and 50 ft. wide, exposing 60 ft. of the 84 in. diameter pipe. The pipe, full of water, hung in mid-air, supported on the ground at one end and on the concrete structure at the other end, until the concrete structure, which was undermined, gave way. The weight of the concrete, and the lack of support at that end of the pipe, of course, bent the pipeline. However, the steel pipe did not break, but merely crumpled in. The crumpled pipe is shown in an accompanying photograph. The pipe crumpled badly across a welded girth seam, but the weld did not crack, even though the temperature was close to 32 deg. F. This is an outstanding example of the quality of modern electric welding.

The chief cost of repairing the break consisted of backfilling the hole and in pouring the new concrete structure. Putting the steel pipe back into serviceable condition was a small matter. The only new material needed was an expansion joint and 7 or 8 ft. of pipe. The 60 ft. of pipe which had been flattened was straightened out and welded back to the undamaged end of the pipeline, cutting out the crumpled section.

» «

Welded Pipe An Important Part Of A Modern Refinery

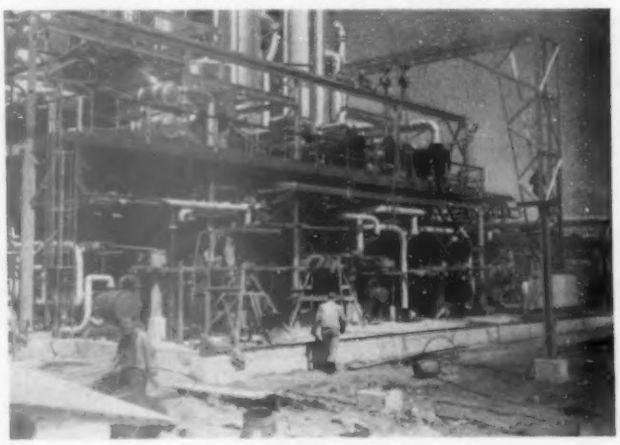
★ Someone has very aptly said, "the piping is just as important to the refinery as are the blood vessels, arteries and veins to the human body." When a refinery consisted merely of shell stills, the necessary piping was a very simple matter. Today the most complicated units include furnaces, fractionating towers, pumps, heat exchangers, condensers, stabilizers, reaction chambers, coke drums, separators and drums, chillers, filters, recording and other instruments.

To connect all these pieces of equipment in the most effective manner many miles of pipe of every description are used. In one large combination unit recently built there were 147,640 ft. of pipe connecting the various pieces of equipment. This pipe weighed 1,444,820 lbs. and varied in size from 1/8 in. diameter up to 20 in. in diameter. On this same job 6,670 flanges were used. In another plant over 300 miles of pipe were used and 10,000 valves installed.

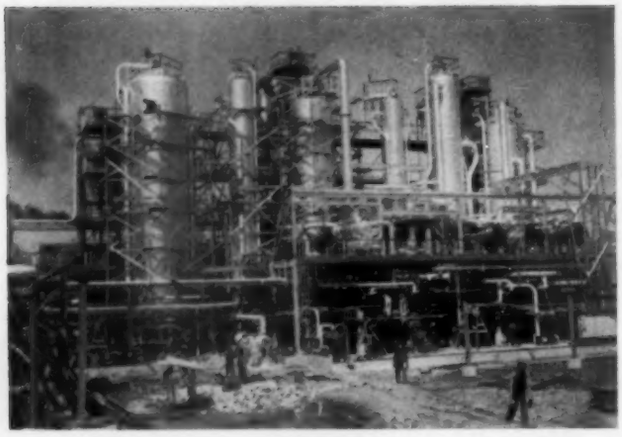
Refinery piping used by the M. W. Kellogg Co., Jersey City, N. J., varies from 3/8 in. to 48 in. in diameter and in wall thickness up to 1 in., and operates at pressures from 150 lbs. up to 3,500 lbs., while temperatures range from 50 deg. F. below zero to 1,110 deg. F. In a big combination unit the weight of pipe used may be as high as 22% of total weight of all metal in the plant.

Piping Design

In locating the various units, with respect to one another, there are many important factors to be considered. In order to keep first cost and operating and maintenance costs low, it is important to have all piping as short as possible. Heat losses, pressure drop, ease of operation and maintenance,



Exchanger and condenser piping at a refinery. Photo (M. W. Kellogg Co.).



Welded piping for main tower and exchanger group. Photo (M. W. Kellogg Co.).

clearances, supports, expansion, stresses and strains, safety, accessibility and operating flexibility all must be given careful attention.

In making the layout, all main, high-temperature and high-pressure lines are given preference, then the details are worked out. Stairs and platforms are provided for efficient operation. The design of piping is an important part of design of the refinery itself. On one job 180 large piping drawings were needed for proper construction and installation of piping.

Provision for Expansion

Expansion is an important problem, due to wide ranges in temperature. At times it is necessary to provide for as much as 12 in. of expansion. Corrosion is another condition to be met when pipes, valves and fittings have to be made of material of extra thickness or of special alloys. On one job all turns were made with flange fittings, with no bends in the pipe, so that the pipe could be taken down at intervals to be calipered on the inside to determine the corrosion effect.

In a dewaxing plant, where temperatures as low as 50 deg. F. below zero are encountered, there are special problems, not the least of which is insulation. In some cases the insulation on pipes is as much as 4 in. thick, thus making a 4 in. line 12 in. in diameter when insulated.

As in all refinery design safety is given first consideration. Usually all piping is designed to be tested under twice normal operating conditions. Even direction of prevailing winds is taken into account, in locating the various units, in order to lessen the fire hazard. The quick movement of product, in an emergency, is also given special attention.

Often special facilities for fabricating pipe in the field are not available. Then it is fabricated and welded at the Kellogg shops. Recently 2,358 pieces of pipe were fabricated and welded at the shops and shipped over 8,000 miles to the Persian Gulf. Only one piece had to be changed on the job. On another job, 4,000 pieces of pipe over 3 in. in diameter, are being fabricated in the shop and shipped to the east end of the Mediterranean.

Piping Made-to-Order

The effectiveness of a refinery is dependent in no small degree upon its piping and it is a "made-to-order" proposition. Outside of a few major fundamentals, there is no such thing as standard practice. Years of experience in layout and design of all kinds of plants and equipment are necessary to insure the best in a piping installation.

Continued from Mr. Saxe's article on page 29.

VAN R. P SAXE

TABLE OF CONNECTIONS B3

Beam Size	Weld each side of web	Conn. Value in kips	Min. Span for shear in ft.	Weld Web @ 18,000	Allow. Web Shear per lin. in.	Beam Size	Weld each side of web	Conn. Value in kips	Min. Span for shear in ft.	Weld Web @ 18,000	Allow. Web Shear per lin. in.
18WF 64	3/8 x 8	45.8	15.4	7.2	4,840	24I120	3/4 x 9	108	14.0	28.7	9,590
55	x 8	44.4	13.2	7.0	4,680	115	5/8 x 10	100	14.7	22.1	8,860
50	x 8	40.7	13.2	6.4	4,290	110	x 10	100	14.4	20.2	8,100
47	x 8	39.9	12.4	6.3	4,200	105[3]	1/2 x 13	104	13.5	15.0	7,500
						100	5/8 x 10	100	11.8	22.4	8,980
16WF114	1/2 x 9	72.0	16.4	15.1	7,570	95	x 10	100	11.5	20.6	8,240
105	x 8	64.0	17.1	14.0	7,010	90	1/2 x 13	104	10.8	15.0	7,500
96	x 8	64.0	15.6	12.8	6,420	85	x 12	94.6	11.4	13.5	6,760
88	x 7	54.4	16.7	12.1	6,050	79[3]	x 12	84.1	12.4	12.0	6,000
78	x 7	56.0	13.7	12.7	6,350						
71	x 7	52.4	13.3	11.6	5,830	20I100	3/4 x 7	84.0	11.8	31.4	10,470
64	3/8 x 8	48.0	13.0	7.8	5,310	95	x 7	84.0	11.4	28.8	9,600
58	x 8	46.4	12.2	7.3	4,890	90	5/8 x 9	90.0	10.4	21.7	8,710
50	x 8	45.2	10.7	6.8	4,560	85	x 9	90.0	10.0	19.6	7,840
45	x 8	39.4	11.1	6.2	4,160	81[3]	1/2 x 10	80.0	11.0	14.4	7,200
40	1/4 x 8	32.0*	12.2	3.7	3,680	75	5/8 x 9	88.4	8.6	19.2	7,700
36	x 8	32.0	10.5	3.6	3,590	70	1/2 x 10	80.0	9.1	13.6	6,810
						65[3]	x 9	66.0	10.6	12.0	6,000
14WF 42	3/8 x 6	30.4	12.0	6.1	4,060						
38	1/4 x 7	28.0	11.7	3.7	3,760	18I 70	5/8 x 7	70.0	8.8	21.3	8,540
34	x 6	24.0	12.2	3.4	3,440	65	1/2 x 9	72.0	8.1	15.1	7,560
30	x 6	22.6	11.2	3.2	3,240	60	x 8	64.0	8.8	13.1	6,580
						54[3]	3/8 x 9	54.0	9.9	8.2	5,520
12WF 36	1/4 x 6	24.0	11.5	3.6	3,660						
32	x 6	22.8	10.8	3.2	3,280	15I 75	3/4 x 6	72.0	7.6	31.1	10,410
28	x 6	20.1	10.6	2.9	2,880	70	5/8 x 7	70.0	7.6	23.1	9,250
25	x 6	20.1	9.2	2.9	2,880	65	x 7	70.0	7.2	20.1	8,070
						60[3]	1/2 x 8	64.0	7.6	14.1	7,090
10WF 29	1/4 x 6	24.0*	7.7	3.4	3,470	55	5/8 x 7	70.0	5.8	19.4	7,780
26	x 6	21.7*	7.6	3.1	3,110	50	1/2 x 8	64.0	6.0	13.2	6,610
23	x 6	20.1*	7.2	2.9	2,880	45	3/8 x 8	48.0	7.6	8.1	5,430
21	x 6	20.1*	6.4	2.9	2,880	42[3]	x 8	46.6	7.6	7.3	4,920
8WF 21	1/4 x 5	18.1*	6.0	3.0	3020	12I 55	3/4 x 5	60.0	5.4	29.1	9,730
19	x 5	17.5*	5.5	2.9	2,930	50	5/8 x 5	50.0	6.0	20.6	8,260
17	x 5	16.5*	5.1	2.7	2,760	45	1/2 x 6	48.0	5.9	13.5	6,790

Pumping unit cranks flame-cut from 3½ in. plate, using a template and magnetic tracing unit.

Oxy-acetylene shape-cutting of

Oil Field Equipment Parts

★ Many shapes must be cut from plates and then joined either to structural shapes or to steel castings, or both

By L. W. STAHL*

Plant Manager and Chief Engineer, Emsco Derrick & Equipment Co., Houston, Texas

OUR COMPANY is a manufacturer of oil field machinery and equipment. It is our business to design and produce such machinery of the very latest type and our endeavor to keep ahead of the operators by anticipating their needs. To do this, we must constantly press our research and engineering departments in the search for new ideas and methods of manufacture. One natural step was the introduction into our plant of oxy-acetylene shape cutting.

We base our manufacture upon the fabrication of machine parts, so far as that type of construction becomes economically possible. By so doing we can offer our customers equipment having all of the strength, light weight and other desirable characteristics of steel as compared with conventional cast-iron construction. Such equipment has also the quality of being readily repaired in the field with a welding torch or arc instead of costly casting replacements. The matter of light weight is probably more important to operators on foreign work or in remote locations than is that of first cost. This latter is of course also favored by welded design. We must frequently join fabricated members of steel castings through the medium of welding.

In the foregoing type of work, we make two principal uses of oxy-acetylene cutting machine. Other than where standard structural shapes are cut and welded, we employ quantities of steel plate in all thicknesses up to 6 in. Innumerable shapes must be cut from these plates and usually they are joined either to structural shapes or to steel castings or to both. Where a sufficient quantity of any one item is to be used, a template is made and the job of cutting is referred to the oxy-acetylene cutting machine. The greater number of parts so formed are cut from plates running ¼ in. to 1 in. in thickness.

We rarely make use of the "stacking" process since our work is generally of thicknesses warranting individual cutting and we find that the set-up time required for stacking is not justified. Much of our fabrication requires the fitting together of cut plate shapes and structural elements within dimensions closer than standard mill tolerances. This means that we frequently cut three or four sides of square or rectangular plates instead of endeavoring to utilize plate in mill strips or universal plate, with possibly ⅛ in. or more plus or minus tolerance in width. Once our template is made and checked to produce the desired fit, we know that all pieces cut from it can be relied

* From the author's paper presented at the 39th annual meeting of the International Acetylene Association, Houston, Texas.

Fabricated gear case for a set of double-reduction gears.

One type of walking beam head for a pumping unit. The side plates are machine flame cut.

upon to assemble within required limits.

Our other great use of the oxy-acetylene cutting machine is in the forming of parts from heavy plate. Many of these parts when finally machined take the place of steel castings. They are produced quickly and are cheaper, the stock costing around 2.7 cents per lb. as against 10 to 20 cents per lb. for steel castings. Only inexpensive templates are needed instead of casting patterns. Such parts are also found to machine more freely than castings and porosity, holes and sand inclusions are not met with. In fact, we "cast" quantities of our simple designs upon our cutting machine.

Again, we find that frequently where we should employ steel forgings we can save money by cutting rings and other simple shapes from plate, thus expediting the job by time required for ordering, making and delivering the forgings. The stock of heavy plate that is necessarily carried to handle such work is much less expensive and is much more flexible as to what may be made from it than would be a comparable stock of castings and forgings for making similar items. We can frequently cut out pieces on the cutting machine that are sufficiently smooth on the cut surfaces so that when welded into an assembly it may be unnecessary to machine some surfaces, where the ordinary forging would present too rough or irregular an appearance.

Sub-assemblies to be used on mud or slush pumps employed in rotary drilling. Fabricated from plates, shapes and some steel castings.

Must Know Shop Problems

It must be borne in mind that as fabricated construction and the use of machine torch cutting are applied to manufacture it is imperative that the equipment being manufactured be designed with particular attention to and knowledge of the shop problems. Proper allowances for shrinkage, warpage and effects of heat upon metal structures need be made by the designing engineer. It becomes necessary that the designer work in close co-operation with the shop, since it is there that the designs and theories are put into practice. We often find that even our best engineers sometimes overlook or are ignorant of shop difficulties to be encountered. We also find that our shop men do not always display the wisdom of the sages. All of which indicates that thought, knowledge and experience must combine to design and produce material by the methods here discussed.

Pumping Unit Crank—This part directly replaces cast steel or cast-iron construction and requires no more machine work to complete it than would the cast pieces. The particular crank shown is cut from 3½-in. plate. Two settings are necessary to obtain the contours in two planes. Two simple templates guide the magnetic tracing finger of the oxygraph with two cutting torches operating simultaneously and cutting two identical designs. These cranks are always cut in appreciable lots so as to maintain a low average cost. The first operation cuts the outer contour of the crank from the flat plate. The second is performed on each pair of cranks as held on edge in a fixture so that the cut is made through the material the thick way.

This slicing operation removes material between the hub and the end, thereby producing a contour similar to a casting in appearance. The weight of the crank as it leaves the machine is 84 lbs. This added to the scrap makes a total of 118 lbs. of plate used for each crank at a material cost of 2.7 cents per lb. With the labor and shop overhead, the piece represents a cost of $5.19. A steel casting could be cored to reduce the weight to 74 lbs. which at 11.4 cents per lb. gives a cost of $8.44. A saving of $3.25 each is made on the cranks and the same subsequent machine operations are required to finish both casting and flame-cut piece.

Gear Case and Side Wall Construction—The pumping unit upon which the above crank is used has a fabricated gear case for a train of double-reduction gears. This case is in turn welded into a fabricated base frame for the unit. The case is completely fabricated with the exception of its cast-iron cover. We found that a simple cast-iron cover can be made more cheaply than a fabricated one. The top of the cover is curved and bears large cast letters upon it. The box proper is built up from five plates; two side walls, two ends and a bottom, all of ⅜-in. material. Small stiffeners, lugs, etc., are also added. Due to the fact that this box when completed must be accurate in dimensions and must fit into the base frame, we have found it advisable to cut the plates on three or four edges, as plate mill tolerances are not adequate.

One set of templates guarantees our dimensions. It is the side wall of the box that draws our particular attention. At the time the plate is set for contour cutting, two openings are cut for the insertion of bearing mountings for the three shafts of the gear case. The bearing mountings are also machine cut from heavy plate. They are welded into the side wall before

"We have developed a nice business in rim replacements on worn sprockets . . . A new rim with machine-cut hardened teeth and a step-cut bore is welded to the old part."

that part is placed in the box assembly. As we have no cast case of this size or type, I cannot present comparative costs. We do know, however, that the two sizes of case that we make in this manner are cheap, light and satisfactory.

WALKING BEAM HEAD—Illustrated are two types of pumping unit walking beam heads. One is a hanger type and one a horsehead. Both are completely fabricated with the exception of a small steel casting welded into the top of the horsehead. The side plates of both types are machine cut jobs.

SLUSH PUMP SIDE FRAME PLATE—We build several sizes and types of mud or slush pumps for circulating the mud-laden fluid used during rotary drilling operations. Two of these pumps are of the power, or gear-driven type. The power ends of these are fabricated from plates, shapes and some steel castings, many of the pieces being flame-cut products.

The side wall of the power frame is a one-piece job done on the cutting machine. The complete contour of the plate together with openings for the doors and for the cast steel bearing housings are cut from one template. The plate is 5/8 in. thick. Torch cutting of these plates by hand would be the only other method of producing them. The saving through use of the machine cutting is evident to say nothing of uniformity of product.

RENEWABLE SPROCKET RIMS—Another item of which we manufacture a considerable quantity is a renewable sprocket rim. The oil industry uses innumerable chain drives, particularly upon the hoist or draw-works of a drilling rig. The sprockets for the drives of this type are generally of cast steel though some are fabricated. Even though the teeth may be machine cut and hardened, the service is extremely severe and in time either the sprocket or its tooth rim needs replacing. We have developed a nice business in rim replacements on worn sprockets. The old rim is cut from the hub or hub flange and for a given size sprocket, the flange is machined with a step-cut to a given standard diameter that we have set up. A new rim with machine-cut, hardened teeth and a step-cut bore is fitted to the old part and welded into place. The result is a new sprocket at a saving in cost of hub and flange section. Another advantage is that the size of a sprocket, new or used, may be changed by this method. A large stock of sprocket templates, for all sizes and numbers of teeth is kept on hand.

By the use of these templates, the machine cuts the complete contour from plate stock, to relatively close machining dimensions, even including the bore for the hub fit. Here the cutting machine is an indispensable adjunct to this job. One might question why we do not cut even more closely to the finished contour of the teeth. We have found that the contour as used permits the cutters of the tooth forming machine to attack the metal at a point a little back from the cut edge, thus preventing rapid dulling of the cutters. An interesting possibility of nesting this type of work is presented, where sprocket rims of several sizes may be cut, one with the other at one setting, thus reducing scrap loss and also set-up time.

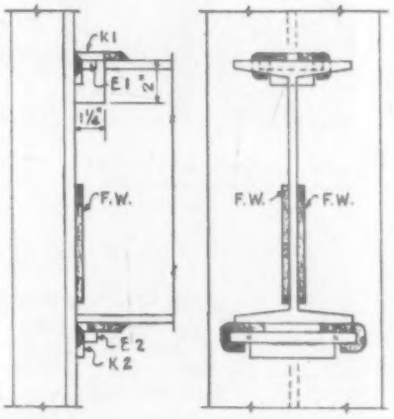
Additional Table of Connections for Mr. Saxe's article. Continued from page 29.

VAN R. P. SAXE

TABLE OF CONNECTIONS B4

BEAM	WELD EACH SIDE OF WEB	CONN. VALUE IN KIPS	MIN. SPAN FOR SHEAR IN FT.	WELD WEB @ 48,000	ALLOW. WEB SHEAR PER SQ. IN.	BEAM	WELD EACH SIDE OF WEB	CONN. VALUE IN KIPS	MIN. SPAN FOR SHEAR IN FT.	WELD WEB @ 48,000	ALLOW. WEB SHEAR PER SQ. IN.
12 I 40	3/8 x 6	36.0*	7.5	8.2	5,520	7 I 20	5/16 x 3	18.0	4.0	8.1	5,400
35	x 6	36.0	6.4	7.7	5,140	17	x 3	18.0	3.8	6.2	4,140
31	x 6	31.5	6.9	6.3	4,200	15	1/4 x 4	15.0	4.3	3.0	3,000
10 I 40	5/16 x 4	40.0	4.7	22.2	8,900	6 I 17	3/16 x 3	18.0	2.9	8.3	5,580
35	1/2 x 5	40.0	4.4	14.2	7,140	14	x 3	18.0	2.7	6.1	4,110
30	3/16 x 6	36.0	4.5	8.0	5,370	12	1/4 x 4	13.7	3.2	2.7	2,760
25	1/4 x 6	24.0*	6.2	3.7	3,720						
						5 I 14	1/2 x 3	24.0	1.5	11.8	5,940
8 I 25	1/2 x 5	40.0	2.6	12.8	6,390	12	3/16 x 3	18.0	1.8	6.2	4,160
23	3/16 x 5	30.0*	3.2	7.9	5,290	10	1/4 x 3	10.0*	2.9	2.5	2,520
20	5/16 x 5	27.1*	3.4	6.3	4,190						
18	1/4 x 5	19.4*	4.4	3.2	3,240						

* CONNECTION VALUES WHICH ARE STARRED, ARE LESS THAN STANDARD RIVETED CONN. VALUES.



DETAILS OF DIRECT WEB WELD CONNECTIONS

1 - ERECTION SEAT (TOP) S.W. 2 x 3/8
2 - ERECTION SEAT (BOTTOM) S.W. 4 x 3/8
K1 - TOP CLIP ⌐ - 2 x 1½ x 3/8 x 0'-2" S.W. 2 x 3/8
K2 - SEAT ⌐ - 2 x 1½ x 3/8 x 0'-3" S.W. 4 x 3/8

BEAMS SHALL BE ORDERED AS NEAR TO EXACT LENGTH AS POSSIBLE.

WELD BEADS GIVEN IN TABLE ARE "NET." SHOULD ANY GAP OCCUR BETWEEN THE BEAM AND THE SUPPORT, THE WELD SIZE SHALL BE INCREASED SUFFICIENTLY TO MAINTAIN THE NET THROAT SECTION.

DISTANCES OUT TO OUT OF TOP CLIP AND SEAT ANGLES SHALL BE EXACT.

OMIT TOP SEATS AND TOP CLIP ANGLES ON ALL BEAMS 8" AND LESS IN NOMINAL DEPTH.

WELDS OF MORE THAN 5/16" BEAD SHALL BE BUILT UP OF MULTIPLE LAYERS.

THE FIELD WELD SHALL BE STARTED AS NEAR THE BOTTOM OF THE BEAM AS POSSIBLE.

ERECTION SEATS ARE PROTECTED BY U.S. LETTERS PATENT No 1,824,631

Brief Sketches of Welding Jobs

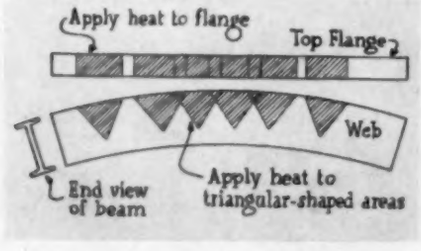
This bent steel spud (used on gold dredge) was straightened by heat applications alone.

One member of spud has just been straightened by using oxy-acetylene torch.

Simple Method Used to Straighten Spud for Dredge

By OWEN H. PERRY*

★ While we were facing the problem of straightening a heavy steel spud used on a gold dredge, we ran across a newspaper story relating how certain members of a steel bridge were straightened in place. This story referred to a technique developed by Joseph Holt of Seattle, Wash. As a "shot in the dark" we contacted Mr. Holt and got one of his booklets, "Contraction—A Friend in Need." We believe that this method is a great advance in the use of the oxy-acetylene torch.



This diagram illustrates theory of differential expansion and contraction as applied in straightening beams.

The spud which we straightened was made up as a box member from four 15-in. I-beams and two ⅞ in. by 24 in. plates. It had an outside dimension of 32 in. by 24 in. and a total length of 50 ft. and weighed approximately 12 tons. Two men with torches straightened this bent member in a day and a half, without bringing any part of the metal to more than a dull cherry red heat and without applying any external force whatever. We moved the spud to dry land before straightening it, but we are convinced now that it could have been done while hanging in position on the dredge.

*Vice-President, Perry-Schroeder Mining Co., Helena, Mont.

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Thermal Forces Alone Will Straighten Bent Steel Sections

By JOSEPH HOLT

★ Ever since the first successful weld was made outside of the laboratory welders have been confronted by two of the greatest forces known in dealing with metals; namely expansion and contraction resulting from a change in temperature. The first force, the welder has usually ignored, while the second he considers as an enemy.

Because we have fought expansion and contraction without studying the natural laws which govern different steel shapes when heat is applied, many fabricated members have been pulled much farther out of alignment than was necessary during the welding process. These members required tremendous force to put them back. Also, members bent in service have been removed from their original positions to be straightened at considerable cost and loss of valuable time because of idle equipment.

Fig. 1—Bent I-beam after nearly one year's service as a crane boom.

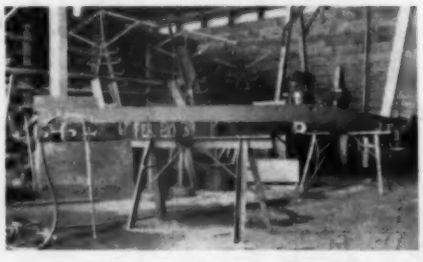


Fig. 2—Straightened crane boom. Only heat applications were employed to do this job. Time—67 min.

First, we must realize the power of these thermal forces. Nothing will hold them. Any opposing force or member must give upset, move, bend, stretch, or break. Therefore, the welder must study very carefully just what takes place when heat is applied to metal, whether with the electric arc or the oxy-acetylene torch, if he is going to get the most out of the welding or heating process. He can keep the members nearer their proper alignment and more nearly free from internal stresses.

How does my contraction method work? First, we must use a fair-sized tip. The torch heat must be applied in such a way that a certain part opposed to that section of the member being heated is left cold and therefore rigid. This rigidness forces the metal which is being heated to expand into itself or "upset."

Fig. 3—Bottom augur of this snow removal machine was straightened in 10 min.

Each heat will upset the metal only a certain amount as the coefficient of expansion is a definite amount for each degree change in temperature. Steel expands and contracts approximately ⅛ in. per foot, if heated to the same temperature as used by the blacksmtih. Hence ordinarily it can be upset only that amount by a heat. In applying my contraction method it is possible to use some of the force of contraction caused by the drop in temperature of the metal from which the torch has passed, so that when no difficulties are encountered, it is possible to get more than ⅛ in. and in some cases up to ¼ in. pull, the same as in welding sheets with the oxy-acetylene torch, where we leave ¼ in. gap per foot of weld. As a rule, a "heat" can be widened out to offset the difference in temperature between a "heat" and a weld; for in this contraction method, none of the metal should be brought to the melting point.

Fig. 4—Bent conveyor frame before repair.

Fig. 5—Nine minutes heat application alone straightened the conveyor frame.

Now let us see a few of the possibilities of this process and what can be done with these two forces, so as to accomplish the desired results. Figure 1 shows an I beam bent after nearly one year's service as a crane boom. No force but *contraction* was used and it was pulled into shape against gravity. The time of actual heating was 67 min. This particular job in ordinary practice with the *contraction* method would

Fig. 6—Truss bars on this tractor-bulldozer were badly stretched, before heat applications were employed to tighten them.

have had some outside force, or at least the weight of the member to assist the heat in upsetting the hot metal and thus cut the time in two.

In clearing the highways of snow, rocks frequently come down in the slides and often get jammed in the augers of the "Snogos." The augers get very badly damaged and have to be straightened. Figure 3 shows the front end of a "Snogo." The bottom auger has been straightened. To straighten one of these augers in any other way would be a very hard task and it would have to be removed; but with the torch and my contraction method, it required but 10 min.

Figures 4 and 5 show a conveyor frame before and after repair. The actual heating time on this job was just nine minutes.

In Figure 6 we have a different application of this process. The truss bars on this bulldozer are of ½ by 8 in. mild steel. They were stretched and sagged so badly that they were not performing their duty, in fact, they were three inches below line. These were tightened in place.

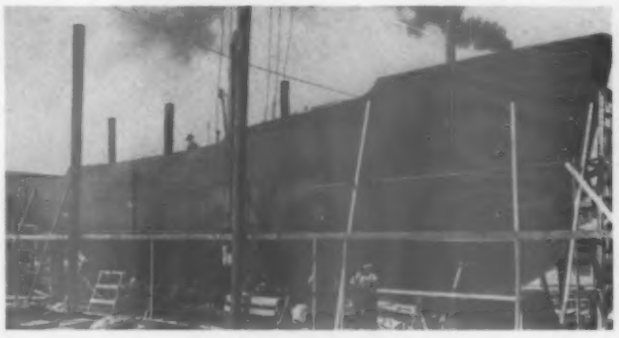
» «

Sardine Purse Seiner Built of Welded Steel

By RAYMOND J. KRANTZ

★ Welded steel construction is today the favored method of building commercial boats. The "Umpqua," a sardine purse seiner built by the Andrew Berg Co. of Seattle, Wash., is an excellent example of modern boat building. This new vessel, when not engaged in fishing service, can be converted readily into an ocean-going tugboat.

"A welded steel boat possesses four definite advantages over a similar type of wooden vessel," says Andrew Berg, the builder: "(1) Welded steel boats are more durable than wood boats; (2) Vibration is reduced to a minimum when properly built; (3) Welded steel boats are more seaworthy than wooden vessels; (4) Welded steel boats are lighter in weight." In cost, the "Umpqua" exceeded the cost of a comparable wooden vessel by about 20%.



Welded hull of the "Umpqua" was completed 34 days after job was started.

Close-up of welded framing in the "Umpqua's" fish hold.

This vessel is 88 ft. 2 in. in overall length, 24 ft. in breadth and a draft of 13 ft. 8 in. when loaded. The fish-holds have a capacity

Looking at the bow after completion of hull welding in 34 days.

Mr. Kaare Berg is flame-cutting one of the plates.

up to 300 tons. Fuel capacity is 18,000 gallons, affording a wide range of operations without returning to shore. There is capacity for 500 gallons of lubricating oil and 2100 gallons of fresh water for drinking and cooking. The "Umpqua" is powered with a 500-hp. diesel engine, which is capable of developing a speed of 12 knots per hour with complete absence of vibration.

One advantage of welded fabrication is the speed with which a boat of this type can be built. The framework was completed within 11 days of the start of construction. Four days later her sheet plates were in position. The hull was completed 34 days

after work was started and the entire construction was completed in 60 days.

The keel was formed of 3 in. x 12 in. x ½-in. channel. The hull plates were mostly 5/16 in. thick. The various plates were rolled to correct curvature at a plant which had proper facilities for such operations. The heavy wood deck beams were bolted to the steel framing.

By using welded construction it was easy to introduce graceful break-aways to the sheer of the vessel as it swung downward from the greatest freeboard at the bow to its lowest freeboard aft near the fish-hold hatch. A welded vessel such as the "Umpqua" possesses extraordinary beauty and trimness of line, quite an advance from the earliest boats which were fabricated by welding.

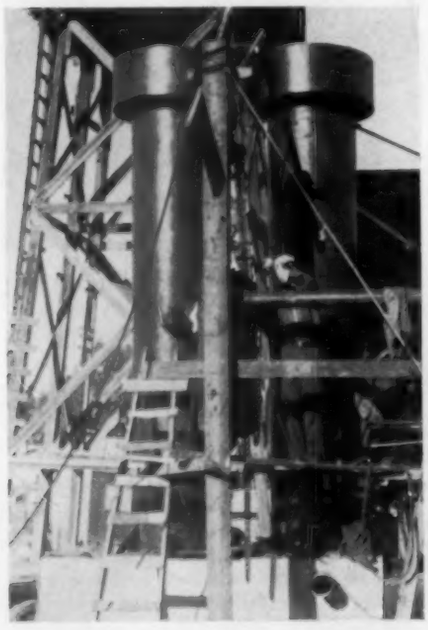
» «

Welding Speeds Reconstruction Job at Ice-Making Plant

By J. C. COYLE

★ Addition of a new cooling tower and two new condensers to increase capacity of the Desert Ice Company's plant in Yuma, Ariz., was a rush job. The change had to be made while the storage supply of ice lasted. Cutting and welding equipment bridged the gap within the limited time available.

An arc welder and two oxy-acetylene units were used for installation work at the plant. A receiver tank, 13 in. x 20 in., a 12 in. x 60 in. purging tank and an oil filter tank, 26 in. x 48 in. were made from used tanks by cutting off the ends, welding in heads and welding up an opening or two. Most of the welding on this job was on numerous pipelines, ranging from ¾ in. to 8 in. diameter. Pipe welding was done largely with oxy-acetylene torches, using 3/16-in. bronze coated rod. A considerable saving in pipe cost was made by purchase of a quantity of used boiler tubes. These were cleaned up and then trimmed with the torch until they



Operator is gas welding a 6-in. ammonia pipe to auxiliary tank.

Making an overhead pipe weld with oxy-acetylene torch.

were equal, if not superior, in strength to new pipe of the grade ordinarily used. Neat and strong joints were secured with the welding torch, and time required for threading joints was saved.

Auxiliary tanks were suspended in position with chain blocks, while the pipelines were cut, bent, and welded into place. Required control valves were also welded into the line. The smaller pipelines were bent at a bench by the welder and his helper. They were heated and gradually bent to the required angle with a bar inserted in the open end, playing the flame on the bend as the need was indicated. Bends in the larger pipes were made by cutting out a section on one side, then heating, bending, and welding the remaining section. Much time was saved by this simple method of making angles in pipelines.

» «

Arc Welding Speeds Production Of Multi-Hydromatic Frames

★ Accompanying illustrations show what is believed to be something unusual in the way of production speed in the manufacture of heavy machinery. The machine frames shown in Fig. 2 are for large hydromatic welders, made by the Multi-Hydromatic Welding & Mfg. Co., Detroit, Mich.

The fabrication of these two large frames was accomplished entirely with two arc welding machines. Only seven days' working time was required to advance the work from the stage illustrated in Fig. 1. The manufacturer of these frames reports that

Fig. 1—Assembly of material for welding large frames for hydromatic welders. Photo (Lincoln Electric Co.).

Fig. 2—Two welded frames after 7 days work, using only two arc welding machines. Photo (Lincoln Electric Co.).

if conventional cast construction had been used, several weeks time would have been required merely to make the patterns. The fabrication of these frames was accomplished by means of arc welders and electrodes supplied by The Lincoln Electric Co.

» «

A One-Ton Welded Crown

★ An impressive tribute to Britain's rulers from one of Canada's great industries took the form of this enormous crown — later raised to the tower of a pulp and paper com-

This welded crown was constructed of pipe, angle iron and sheet metal. Photo (Linde Air Products Co.).

pany in time for the royal visit to Quebec. The crown, approximately 20 ft. in height by 16 ft. in width, was built of pipe, angle iron, and sheet metal, welded together by the oxy-acetylene flame. Its weight was only 2,000 lb., because welding eliminated nearly all bolts and overlapping surfaces. The decorative, heraldic effect of the fleurs-de-lis and military crosses along the top edge of the base was obtained by oxy-acetylene flame-cutting of the pieces from steel plate and then welding them to the assembly.

News of the Industry

Annual Meeting A.W.S.

The 20th annual meeting of the American Welding Society will be held in Chicago during the week of October 22-27. All meetings will be held in the Stevens Hotel. A total of 56 technical papers are scheduled for presentation. Full details of the program including social and entertainment features will be found in the September, 1939, issue of The Welding Engineer.

Metal products companies and welding equipment manufacturers appear optimistic about prospects for business during the coming year, judging from the record of reservations for the 1939 National Metal Congress and Exposition. The five-day Exposition will be held at the International Amphitheatre, 4200 So. Halsted St. in Chicago, October 23-27, 1939.

William H. Eisenman, secretary of the American Society for Metals and managing director of the Congress, reports that space for this year's showings of metallurgical and welding progress is 95% reserved; this, with little over two months remaining before the Show. This figure represents a 15% increase in space over last year.

STREAMLINED TRAINS MAKE MONEY—The first of the American lightweight, welded streamlined trains went into service in 1934. About 80 of them now are operating on some 20 railroads. They were, and still are, a new development in the long and romantic story of American transportation. However, the most striking thing about them, perhaps, is the fact that every lightweight, streamlined, high-speed train operating in the United States has meant additional passenger traffic and substantial earnings for the railroad placing it in service.

The welded stainless steel, lightweight Zephyrs (Burlington) moving between Chicago and Denver, showed the highest ratio of earnings for any train of the new type, for the year ending June 30, 1938. With a gross revenue of $2,088,938 these trains earned a net of $1,568,831. This was 75.1% of gross or $2.07 per train-mile.

The high-speed welded streamlined Hiawathas, (Milwaukee Road), between Chicago and the Twin Cities had a gross revenue of $1,337,898, with net earnings of $3.22 per train-mile or 74.1% of gross.

Usually the new trains show a steady increase in revenues for a considerable period after going into service. The El Capitans (Santa Fe), between Chicago and Los Angeles went into action in February, 1938. They produced $8,000 in revenues that month; $38,000 in March; $49,000 in April; $83,000 in May and $101,000 in June.

These streamliners seem to be an excellent answer to the question "What can the railroads do to help themselves?"

» «

CHICAGO SECTION, A.W.S. HOLDS FIRST GOLF TOURNAMENT

All devout followers of the ancient and honorable game of golf, made a pilgrimage on July 15 to the Gleneagles Golf Club near Lemont, Ill., to attend the first annual golf tournament ever held by the Chicago Section. In addition to 113 who registered for golf, there were about 15 others who came out for the luncheon, dinner and social features. A total of 39 prizes were distributed to the most skillful and luckiest welding golfers. Some of the prizes were based on the player's luck in establishing a good handicap on a few "blind" handicap holes. The prizes were donated by 40 manufacturers and local representatives, whose loyalty and enthusiasm helped to make the event a huge success.

This 1939 tournament marked the establishment of the Chicago Section Golf Cup, which will become the permanent possession of the Chicago Section member who is three times winner of the low gross title. O. L. (DUKE) HOWLAND won the 1939 low gross title among A.W.S. members. He will retain possession of the cup for one year. R. N. HIXSON turned in the lowest gross score at the tournament, but was ineligible for the cup because he is not a member. Another cup, known as the Bastian-Blessing Cup, was won by R. G. WILSON, for turning in the lowest net score. Still another cup known as the Rego Cup, a marvel of engineering skill, was also donated by the Bastian-Blessing Co. for the highest gross score. The winner of this cup is still unidentified at the time of going to press. ALDEN SWIFT won the "door prize," a valuable set of steel knives, donated by Bob Mason, welding foreman at the Santa Fe's Corwith Shops (Chicago).

W. C. PEARSON was general chairman in charge of the Golf Committee. He was assisted by O. L. HOWLAND, chairman of the Committee on Location; by CLYDE BASSLER, chairman of Committee on Prizes and Entertainment; by BOB KOHLBRY, chairman of the Starting Committee; and by M. S. HENDRICKS, chairman of the Committee on Advertising and Publicity.

Five of the Santa Fe's new "fleet" of 13 streamliners, lined up for dress parade in the Chicago terminal. These trains are producing a profitable increase in railroad passenger business.

Welding has played an important part in the building of equipment used by ranch operators in the Imperial Valley, California. Here is a novel hay bale pick-up that eliminates a great deal of strenuous manual labor. Photo (F. Hal Higgins).

A home-made power mower built in a ranch operator's welding shop in Livermore Valley, Calif. This hybrid machine was evolved by "crossing" an old Chevrolet motor with a Studebaker radiator, a Model T Ford rear end, an International Harvester pittman shaft, and a few Case tractor parts (thrown in for good measure). Speed—5 mph. Photo (F. Hal Higgins).

» «

TESTING SMALL SCALE WELDED MODELS DEVELOPS VALUABLE DATA ON STRESS RELIEVING

Successful tests of an all-welded model of a plate girder have been completed in England. These tests will contribute to a better understanding of many engineering problems encountered in building full size all-welded structures for skyscrapers, bridges, ships and houses, it is reported by the Welding Research Committee of the Engineering Foundation, New York City. Cost of experimenting with models weighing less than 60 lbs. is but a fraction of that entailed in using an ordinary girder weighing more than 7,000 lbs. This makes it possible to investigate a wider variety of designs and methods of fabrication. Results of such studies will lead to more economical and safer constructions, the report declares.

There is an increased demand for all-welded structures because they are lighter,

cheaper, and as strong or stronger than the riveted type. For example in 1938, 138 of the 155 vessels constructed under 300 ft. were all-welded. In 1930, of the nearly 120 vessels built, less than 5 were all-welded. In recent years larger ships, including 18,000 ton oil tankers, have been all-welded.

Most important result of the English tests, from point of view of the building industry, was substantiation of the belief that external loading releases, in a considerable degree, residual strains and stresses in correctly designed all-welded mild steel structures. Engineers have long been critical of all-welded girders, it is explained, doubting their ability to hold up under heavy external loadings because of the strains and stresses put into the girders by the welding process. The experiments revealed that, as far as static loads were concerned, their application relieved these inner strains and stresses.

» «

NEW FELLOWSHIP IN METALLURGY ESTABLISHED AT CARNEGIE TECH — Industry and education forged another link in their chain of coordinated research and training with the announcement by Carnegie Institute of Technology of a Westinghouse Fellowship for graduate study in metallurgy. DR. R. F. MEHL, director of the Metals Research Laboratory and head of the department of Metallurgy at "Tech," said the fellowship would continue for a three-year period and provide $1,200 a year to the recipient for graduate study and research in metallurgy.

FREDERICK C. HULL, of Ann Arbor, Mich., a graduate of the University of Michigan in 1937, has been selected as the first Fellow under the plan. During 1939 and 1940 he will continue his studies in reactions of steel, which he has been pursuing for the past two years as a teaching assistant in the department of metallurgy.

Obituary

CHARLES KNIGHT, a pioneer in the welding industry in Chicago, died on July 18 at his home, 113 So. Oakley Blvd., Chicago. Nearly 30 years ago Mr. Knight had a welding shop located at Jackson and Canal streets in Chicago. After the World War he was instrumental in the formation of the Welders' Club, which aimed to help welders in search of employment.

Personals

HAROLD L. NORWAY has been appointed assistant engineer of the Liquefied Petroleum Gas Division of The Bastian-Blessing Co. Mr. Norway comes to the organization with a background of long experience in the regulatory phases of the industry. For the last several years he has been an engineer for the Gas and Oil Department of the Underwriters' Laboratories, Chicago. Mr. Norway is a graduate of the Case School of Applied Science with the degree of bachelor of science in mechanical engineering.

HAROLD L. NORWAY

» «

LESTER M. CURTISS, who has been assistant general superintendent of Lukens Steel Co., Coatesville, Pa., has been appointed general superintendent in charge of all operations. Mr. Curtiss succeeds G. DONALD SPACKMAN, who has been granted a leave of absence at his own request in the interest of his health.

Mr. Curtiss was born in April, 1893, at Norfolk, Conn. In 1919, he joined Lukens Steel Co. as assistant engineer of tests, holding that position until 1923 when he was made engineer of tests. Subsequently Mr. Curtiss was assistant superintendent of plate mills, then superintendent of plate mills, and then superintendent of production which position he retained until his promotion to assistant general superintendent in 1936.

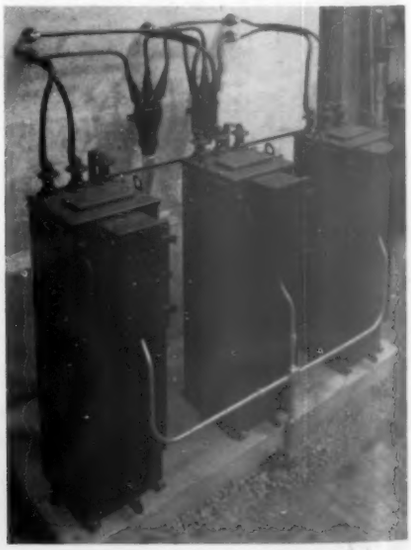
LESTER M. CURTISS

FRANK DELARZELERE, formerly vice-president and general manager of National Butane Gas Co. of Memphis, Tenn., has joined The Bastian-Blessing Co. organization as district manager. He will make his headquarters at Columbus, Ohio. Mr. DeLarzelere has had many years experience in the sales promotion of gases and fuels. Prior to his connection with the National Butane Gas Co., he was district sales manager for the Standard Oil Co. of Louisiana.

FRANK DE LARZELERE

» «

TED WILSON has been appointed Pacific Coast district manager for The Bastian-Blessing Co., of Chicago. He will make his headquarters in Los Angeles. Mr. Wilson has had many years experience in the manufacture and marketing of equipment used to control high-pressure gases such as oxygen, acetylene and liquefied petroluem gas.



These regulator tanks are made to take fullest advantage of welded, structural-steel construction. Photo (Westinghouse).

He is a graduate of the University of Pittsburgh, where in addition to studying engineering he played football under "Pop" Warner and "Jock" Sutherland.

TED WILSON

» «

ERNEST A. FAULHABER RETIRES—After 25 years of service with Compressed Industrial Gases, Inc. and its predecessor companies, ERNEST A. FAULHABER has retired as executive vice-president, effective August 1, 1939. Mr. Faulhaber retains his interest in the company and will remain as a director and will also serve in an advisory capacity.

Mr. Faulhaber was born July 1, 1868, at Jefferson City, Mo. After working at various railroad jobs, he completed a law course at the University of Minnesota in 1898, receiving the degree of L.L.B. The following 16 years were spent in railroad construction activities, mostly in Tennessee, Florida, Texas and Missouri. In 1914 Mr. Faulhaber became interested in the compressed oxygen industry which was then in its infancy. He was associated with Harold S. Cook, of Chicago, in building an oxygen plant in Detroit, Mich., which plant was placed in operation in September, 1915. Subsequently, he was engaged in building and operating additional oxygen plants in Fort Worth, Texas, and Pittsburgh, Pa., all of them using electrolytic equipment purchased from Burdette Mfg. Co., of Chicago. Mr. Faulhaber was president of the three operating companies with plants in Detroit, Pittsburgh, and Fort Worth. Subsequently, additional plants were installed at Chattanooga, Tenn., and Oklahoma City, Okla., and in 1917 a consolidation of all Burdett-equipped plants was effected. In 1928 these plants were consolidated into Compressed Industrial Gases, Inc., of which company Mr. Faulhaber was executive vice-president until his retirement.

Mr. Faulhaber is a past president of the Compressed Gas Manufacturers' Association, and at the present time is a member of its executive board. He is also a member of the board of directors of the International Acetylene Association.

ERNEST A. FAULHABER

Construction

THE PLAINS PIPE LINE CORP., Levelland, Texas, is planning to build a welded pipeline from the oil fields in Cochran and Hockley counties (Texas) to Levelland, a distance of about 35 miles. A new refinery is also to be built at Levelland.

» «

A NEW TYPE OF WELDED DIRIGIBLE—Welding is playing an important part in the construction of a new, revolutionary type of dirigible, being built at Camarillo, Calif., by Thad Rose, the inventor. It is said that the dirigible, which will be 147 ft. long and 49 ft. in diameter, will be able to ascend and descend vertically, carry 13 persons, and will cost $15,000. The ribs and surfaces will be of welded aluminum, with piano wire for stays and braces. It will be propelled by six 50-hp. engines.

» «

BETHLEHEM STEEL CO., Los Angeles, Calif., has been awarded a contract by Douglas Aircraft Co., for construction of a welded structural steel building to be used as an assembly unit at the company's plant at 3000 Ocean Park Blvd., Santa Monica, Calif.

» «

WELDED PIPELINES—Construction will start shortly on a welded pipeline from the La Rosa field in Refugio County, Texas to the Corpus Christi Ship channel. The line, owned by the Corpus-Rosa Pipe Line Co., will include 27 miles of 6-in., and 10 miles of 4-in. line. Welded storage tanks will be constructed at both ends of the line. Work has started on the 35-mile 8-in. welded pipeline of Standard Pipe Line Co. of Louisiana, to extend from Haynesville, La., to the Magnolia, Buckner and Village fields, of Columbia County, Ark.

» «

AN ALL-WELDED FURROWING MACHINE designed for use in the citrus groves of California, has been developed for the U. S. Division of Irrigation, by the Munsell Welding Works, of Pomona, Calif. Features of the machine are a hydraulic lift; quick adjustment for distance between furrows and depth. A collapsible and folding feature affords quick and safe transportation from one location to another. The implement is 100% welded.

Trade News

LOWER PRICES FOR SIL-FOS AND EASY-FLO BRAZING ALLOYS—In keeping with the recent reduction in the price of silver, Handy & Harman has announced a revised schedule of lower prices for their brazing alloys, SIL-FOS and EASY-FLO. Changes in shipping arrangements have also been made which are more favorable to users. A new printed price list is ready for distribution. Copies can be obtained from Handy & Harman, 82 Fulton St., New York City, or from their distributors.

» «

STULZ-SICKLES CO., 134 Lafayette St., Newark. N. J., has recently appointed the following distributors: The Fulton Supply Co., 342 Nelson St. S.W., Atlanta, Ga.; The Reno Motor Supply Co., Reno, Nev., and the Wm. M. Orr Co., 1228 Brighton Road, Pittsburgh, Pa. These firms will distribute Manganal Bare and Tite-Kote welding electrodes, applicator and wedge bars and Seaco hard-surfacing welding electrodes.

» «

CRIS-WELD SUPPLY CO., 1320 Dodge St., Omaha, Nebr., has recently been formed by B. W. CRISWELL, to handle welding equipment and supplies in Omaha. This new company will distribute Oxweld welding rods and supplies, Purox welding and cutting equipment and Lincoln Electric welding electrodes and supplies.

» «

NORMAN A. EVANS has recently been appointed sales manager for Pressed Steel Tank Co., Milwaukee, Wis.

» «

THE LINCOLN ELECTRIC CO. Chicago office has moved from 1455 W. 37th St. to 600 West 41st St. At the new location, Lincoln Electric Co. has greatly improved facilities for exhibiting its welding machines and for conducting demonstrations. G. E. TENNEY is Chicago district manager.

» «

R. C. NEAL CO., Buffalo, N. Y., has been appointed a distributor for products made by Progressive Welder Co., Detroit, Mich. GEORGE SCHLICKER, of the Neal Co. will be in direct charge of sales of Progressive welding machines and equipment in the Buffalo area.

» «

WESTINGHOUSE ORDERS UP 36% — Orders booked by Westinghouse Electric & Mfg. Co. in the first half of 1939 rose 36%, to reach a total of $104,538,863, in comparison with $76,713,806 booked during the first six months of 1938. Improvement in sales was reflected in virtually all lines of Westinghouse business, and especially in merchandising, lamps, central-station and industrial apparatus, and marine equipment.

An increase of 6% over the first six months of last year was shown in sales billed for

the first six months of 1939: $87,716,903 against $82,808,754. Net income for the half year showed an increase of 41%: $6,338,787 against $4,500,602.

» «

Sales billed by General Electric Co. during the first six months of 1939 amounted to $146,299,212, an increase of 12% over the $130,910,638 billed in the corresponding period of 1938. Profit available for dividends for the first half of this year amounted to $16,370,192, compared with $13,176,956 for the first half of 1938, an increase of 24%.

Orders received during the first six months this year amounted to $169,071,646, compared with $128,223,823 for the same period last year, an increase of 32%.

» «

The Metallizing Co. of America, Inc., has recently opened a sales and service office at Newark, N. J.—602 Academy Building, 17 Academy St. William McMarkin in charge. Complete parts on Mogul metallizer guns are available for prompt shipment, as well as metallizing wire. Engineering service on metallizing problems is also available.

» «

Cash for Ideas—It pays to think in General Electric Co., for during the first six months of this year the company under its suggestion system paid $32,570 to employes who submitted new ideas. The number of suggestions received for this period this year showed a 25% increase over the first six months of 1938. There were 15,407 new ideas submitted as against 11,545 last year. Likewise there was an increase in the number of ideas adopted (5,304) or 15% more than in 1938.

» «

C. E. Phillips & Co. has moved its Chicago office from 324 So. Jefferson St. to 332 South Jefferson St. "Jack" C. Menzies is district manager.

Current Reviews

Machine Design Textbook—S. E. Winston, associate professor of mechanical engineering at Armour Institute of Technology, Chicago, is the author of a new textbook "Machine Design" published by American Technical Society, 5800 Drexel Ave., Chicago, Ill.

Underlying the entire field of machine design there are many basic fundamentals of theory and analysis and a great deal of factual information with which any prospective designer must be acquainted. This book deals with these basic fundamentals in a practical, "how-to-do-it" manner. It is assumed the reader has completed the subject of mechanism and that his mathematical knowledge extends only through trigonometry and logarithms. Therefore, the calculus has not been resorted to. Thus several rational formulas are included for which no derivations are given.

Prof. Winston's book contains 333 pages, 145 illustrations and 26 tables. The price of the book is $3.00. We have noted one serious deficiency in this "Machine Design" textbook; notably the omission of design data dealing with welding. The author has included 25 pages of text dealing with design of riveted joints, but he has failed to include any information dealing with welded joints. The contents of the book are presented in a simple "how-to-do-it" style, with numerous examples showing the student how to carry out the design calculations.

Recent Patents

Welding Rod

2,158,984. Arthur R. Lytle and Thom. H. Vaugh, Niagara Falls, N. Y., assigned to Oxweld Acetylene Co. of W. Virginia. Filed May 13, 1938. Issued May 16, 1939. Thermo-plastic synthetic resins are employed as binders for coating welding rods with solid subdivided weld-modifying substances. The rod comprises a metal core and an adherent coating containing a resin selected from the group consisting of polyvinyl halides, polyvinyl esters of aliphatic acids, polystyrene, and polymerized esters of acrylic acid and its homologues; which resins burn slowly in a welding flame without yielding disagreeable fumes or odors and without depositing a char that would interfere with the welding operation.

» «

Welding Studs to Tubes

2,159,059. James E. Trainer, Fairlawn, Ohio, and others, assigned to Babcock & Wilcox Co., Newark, N. J. Filed Dec. 28, 1936. Issued May 23, 1939. The patent relates to a machine for welding metallic projections such as studs to tubes. Such welding is done, for example, in attaching studs onto tubes used in boilers. The machine automatically establishes a predetermined space relation between studs successively connected.

» «

Automatic Welding Unit

2,159,860. Henry T. Platz, Detroit, Mich. assigned to Briggs Mfg. Co., Detroit, Mich. Filed May 23, 1938. Issued May 23, 1939. Automatic introduction and removal of work is provided by a machine described in this patent. The device has a work supporting carriage movable from a loading station to a position wherein the work is in registration with the welding electrodes. The carriage operates elements in timed relation to movement of the carriage to move the work off the carriage into operative relation to the electrodes. There are also timed elements to move the electrodes into and out of clamping engagement with the work, as well as timed units for closing and opening the circuit in timed relation to movement of the electrodes into and out of clamping engagement with the work.

» «

Electric Percussive Welding

2,159,916. Alfred Mang, Detroit, Mich., assigned to Vanco Products, Detroit, Mich. Filed Dec. 1, 1937. Issued May 23, 1939. According to this patent, similar metals and alloys, as well as metals of different melting points and hardness, may be flash welded by effecting an electrical discharge of decreasing amplitude and of sufficient voltage to set up arcing conditions between the surfaces to be welded, before the surfaces are initially brought together. The current must be of sufficient heat producing power to bring the surfaces only to a molten condition, a substantial amount of energy of the discharge being utilized to heat the surfaces of the metal bodies before the bodies are initially brought together. Immediately following the arcing described, percussive engagement of the surfaces to be welded is effected, while the surfaces are still molten and before a substantial amount of the heat produced has been conducted away. The process uses a high enough voltage to jump a gap between the metals being welded before they are contacted. This causes the metals to be molten before contact. At least 500 volts should be employed. As much as 1000 volts, or even higher, may be used in this process.

» «

Universal Welding Head

2,160,048. Allen D. Wiley and William H. Franzmann, Middletown, Ohio, assigned to The American Rolling Mill Co., Middletown, Ohio. Filed May 14, 1937. Issued May 30, 1939. Where it is necessary to change from one type of welding rod to another, such as for example, from a bare to a coated rod, the invention provides a universal welding head, which may be efficiently used with any type of welding rod. The head comprises a frame, a feeding motor mounted on the frame for reciprocal movement, and a device for oscillating the head as a unit by causing reciprocating movement of the feeding motor. The machine has a feeding means which grips a coated or uncoated rod without slippage, and which does not injure the coating of a coated rod. A milling attachment is provided for insuring a uniform depth cut in a coated rod.

» «

Welding Alloy

2,160,423. Winston F. Stoody, Wilmington, and John R. Spence, Whittier, Calif., assigned to Stoody Co., Whittier, Calif. Filed Jan. 25, 1937. Issued May 30, 1939. The inventor has discovered that it is possible to produce an alloy of iron, cobalt, chromium, and tungsten, wherein there is a relatively large proportion of iron. The large quantity of iron reduces cost of composition; yet, the alloy does not suffer from the large amount of iron present. The alloy is composed of 40% to 50% of iron, substantial amounts of cobalt, chromium, and tungsten, aggregating between 40% and 50%, there being also present molybdenum, vanadium, and carbon. The vanadium contributes to hardness and toughness. It also acts as a welding deoxidizer. The alloy is hard, tough, weldable, and corrosion and abrasion resistant. Not less than 40% nor more than 50% of iron should be used. If too little iron is used the alloy is brittle; and if too much iron is employed, the alloy is not abrasion resistant. The cobalt tends to make the rod run well in welding. It also contributes to toughness and gives the alloy the desired metallic color. The chromium contributes to abrasion resistance, due probably to formation of chromium carbides.

"Hoist away," signals the shop foreman, and this 74-ft. welded evaporator bubble tower is swung to waiting railroad cars to begin its long trek to Gonfreville, France, on the lower Seine. More than 10 ft. in diameter at its widest point, the vessel is built in accordance with A.P.I.-A.S.M.E. codes and is stress relieved. It is lined throughout with chrome-alloy sheets of uniform thickness to resist attacks of corrosive crudes. Photo (A. O. Smith Corp.).

Welding structural framework for roof of new quarter million square foot windowless plant being constructed by The Austin Company for the Allison Engineering Division of General Motors Corp. at Indianapolis, Ind. In designing this controlled-conditions plant, which will be devoted exclusively to manufacture of liquid-cooled aircraft engines, Austin engineers provided penthouses for accommodation of washrooms, lockers and air-conditioning equipment. The brick wall supporting the bottom of one of these penthouses can be seen in the background, resting directly on the electrically-welded trusses which were fabricated at the Austin shops in Cleveland.

This cast-iron deer was assembled with the aid of bronze welding. This method of building ornamental statuary gives the designer greater freedom for his creative talents and simplifies the job of construction. Photo (W. E. Archer).

What would you do in an emergency like this?

A GREAT LAKES FREIGHTER was carrying a valuable cargo of perishable goods when its engine suddenly became disabled off Fort William, Ontario.

Hurried examination revealed the badly cracked iron casting shown above. Because of the cargo, minutes meant dollars, and repair-welding was obviously the only way out.

Before looking to see how this problem was solved, why not figure out what you yourself would have done. 39133

Check your answer with the solution on page 47

Molybdenum promotes fluidity, which is desirable for deposition of thin layers of the metal.

» «

ROD FEED CONTROL

2,160,480. ROBERT G. LE TOURNEAU, and others, Peoria, Ill., assigned to Le Tourneau, Inc., of Calif. Filed Feb. 28, 1938. Issued May 30, 1939. Feeding of a rod is controlled by changing the welding current voltage in such a manner that the length of the welding arc is maintained substantially constant.

» «

TUBE WELDING

2,160,586. JOSEPH H. GETTIG and GEO. SPATTA, Buchanan, Mich., assigned to Clark Equipment Co., Buchanan, Mich. Filed Sept. 10, 1937. Issued May 30, 1939. It is essential in order to practice the welding of strip stock into tubular form economically, to obtain as high a welding speed as is consistent with the forming of a good weld. According to this patent high welding speed may be used by welding with an atomic hydrogen multiple-arc head. This head provides spaced pairs of tungsten electrodes having the respective pairs of arcing tips offset longitudinally in the cleft.

» «

CONTROLLED WELDING PATH

2,161,121. JAMES L. ANDERSON, Closter, N. J., assigned to Air Reduction Co., New York, N. Y. Filed Feb. 10, 1938. Issued June 6, 1939. Torch movement along a desired course is made possible with a device described in this patent. The device moves the torch in any and changing directions in a plane along a path determined by a tracing device, or along a straight line with or without tracer guidance. The speed of movement of the torch carriage is also controllable.

» «

PRESSURE EXERTING ELECTRODE

2,161,467. FRANZ R. HENSEL and EARL I. LARSEN, Indianapolis, Ind. Filed June 15, 1937. Issued June 6, 1939. An electrode composed of about 0.1 to 10% zinc, 0.1 to 5% zirconium, and the remainder copper is covered by this patent. The alloy has high hardness and high electrical conductivity. It is suited for spot welding. A second patent to the same inventors, No. 2, 161,468, filed Feb. 24, 1939, describes an alloy of .002 to .1% lithium, .1 to 5% zirconium, and the balance substantially all copper. This alloy has a good thermal conductivity.

Features which assure SUPERIOR WELDING QUALITIES of

Use of Purest Raw Materials Obtainable, such as Electrolytic Copper 99.96 in purity and Electrolytic Zinc 99.99 plus.

Strict Laboratory Control; Uniformity of Mixtures and Casting Temperature.

Double-Deoxidation Process which eliminates injurious gases.

PENN BRONZE—a general-purpose rod, melting at 1620° F. Tins readily and uniformly on galvanized, malleable or wrought iron, as well as steel, brass, bronze and any other non-leaded metal with melting point above 1850° F.

TITAN MANGANESE BRONZE—especially adapted to production of tough, hard deposit. Particularly recommended for cast-iron repairs, where extremely dense, non-porous weld is essential.

Submit your particular bronze-welding problem for solution by our engineers. Recommendations gladly forwarded, together with generous sample for trial in your own plant.

Titan Metal Manufacturing Co.
Bellefonte, Pennsylvania

Trade Literature

BIT MANUFACTURE DISCUSSED—The paper, "Some Defects Found in Hard-Faced Drilling Tools—and Their Remedies," presented by C. W. METZGER of Haynes Stellite Co. at the Oil-World Exposition held recently in Houston, Texas, has been issued in the form of a 20-page booklet. This paper is an intensive discussion of the subject, and describes a large number of cases and, by photo-micrographs, illustrates most of the common bit defects. The text explains how to obtain correct base metal structure, strong tungsten carbide insert-to-steel bonds, and good tungsten carbide grain-to-steel bonds. The effect of dissolved tungsten carbide on the base steel is discussed in detail. Copies can be obtained from either Oil-World Exposition, Inc., Houston, Texas, or Haynes Stellite Co., Kokomo, Ind.

» «

"TREMENDOUS TRIFLES" is the title of a new booklet issued by The International Nickel Co. which emphasizes importance of small items of equipment, such as springs, bolts, electrical contact points and the like in making the wheels of industry run smoothly. Sixteen pages in size, with illustrations and charts, it presents technical and mechanical data on nickel, Monel, Inconel, "Z" Nickel, "K" Monel, and other high-nickel alloys. The booklet is being distributed by The International Nickel Co., 67 Wall St., New York City.

» «

WELDING CATALOG ISSUED BY IMPERIAL BRASS—A new 24-page catalog, showing the complete line of Imperial oxy-acetylene and oxy-hydrogen welding, cutting, brazing and lead-burning equipment, soldering equipment, gas and air torches and welding supplies, has just been issued by The Imperial Brass Manufacturing Co., 1200 W. Harrison St., Chicago, Ill.

Among items shown for first time in this catalog are a new universal welding torch, with improved cooling design, new regu-

lators, three soldering outfits and a paint burning outfit. Supplies shown include a wide range of gauges, regulator adapters, hose, hose connections and clamps, goggles, flux, spark lighter, cylinder trucks, solder, etc. The catalog explains trade-in allowances which are given to customers who trade-in their old equipment on new Imperial apparatus. Copies of this new catalog (No. 334) can be obtained by writing to the manufacturer.

Foreign News

All Welded Steel Boiler Successful in London

All-welded boilers are still a considerable novelty in Britain and the success of one installed 6 months ago at the works of G. A. Harvey and Co., London, alongside two riveted boilers of the same type for the firm's high-pressure hot water heating system, has attracted wide interest among English engineers. No leakages or trouble of any kind whatsoever have been experienced with this welded boiler.

The boiler is 9 ft. 9 in. in diameter, and evaporates 10,000 lb. of steam per hour at a working pressure of 180 lb. The shell plates are 15/16 in. thick. All joints are butt welded, a single U-type joint being employed. The end plates are flat and flanged around the edge and for the furnace tubes. The thickness of these plates is also 15/16 in. For about 50% of their length the furnace tubes are made as corrugated flues to take up the expansion. The remainder are composed of electrically-welded tubes, thus eliminating circumferential riveted joints which would occur in the flanged flue rings used in riveted boilers.

The plain flue tube is provided with rings of flat bar section, welded around the outside in the water space, the diameter of these rings permitting the flue to be withdrawn through the front flue hole for subsequent replacement. The standpipes are of flanged steel without a base flange, but are fitted round the openings cut in the shell plates with external compensating plates welded on.

In connection with smoke tubes and stay bolts it was decided to adhere to the practice of expanding in the plain tubes, screwing in and expanding the stay tubes, and screwing and nutting the stay bolts, although the welding in of all these items could have been effectively carried out.

The boiler was built to Lloyd's Class I requirements for fusion-welded vessels. The welded joint efficiency for butt joints was calculated at 85%. All plate edges were planed for welding, a single U-type butt weld being used throughout. All welded seams were x-rayed and no imperfections of any kind were allowed in the weld. The usual coupon test plates were welded simultaneously with the welding of the longitudinal weld seams, one at each end of the seams. The boiler plate used in the manufacture of the boiler had a strength of 26-30 tons per sq. in.

After completion the boiler was subjected to a hydraulic test of 320 psi., the welded parts being hammered under pressure. There were no signs of leakage at any joint.

After welding of the boiler was completed, but before expanding in of the tubes, the boiler was placed in a gas-fired furnace and stress-relieved at 650 deg. C. for one hour.

Among other proved advantages, the construction of this boiler on the all-welded principle resulted in a saving in cost of manufacture of 13½% compared with a riveted one of similar size and design.

» «

Norway to Build Welded Hulls — The Norwegian Government is now considering plans for erection in the near future of a new shipyard, probably at Sjursoeya, for the series construction of ships' hulls. Provisionally, the yard would concentrate on all-welded combination ships of about 15,000 tons. The hulls would be delivered to other Norwegian yards for installation of machinery and equipment.

The new yard will employ at least 500 men, and it is estimated that, if necessary, the yard could launch one welded hull monthly. A new company will probably be established to operate the yard. The cost of erecting is estimated at between 5,000,000 and 6,000,000 kronen (about $1,400,000).

Classified Section

ADVERTISING RATES

Help Wanted — 75c per line, minimum 4 lines. Jobs Wanted — 4 lines free. Other Ads — $1.00 per line, minimum 4 lines. Count 8 words to line. Add 6 words for keyed address.

FOR SALE

Welding and Radiator Shop—Well equipped and established in fast growing community of 8,000 population for quick sale. Situated in rich farming center in Florida. Address Au-1, The Welding Engineer.

Bargains—Demonstrator Arc Welders. Gasoline and electric drive. 30 days' trial. Easy terms if desired. Write Hobart Welder Exchange, Box U-891, Troy, Ohio.

For Sale—Acetylene Welding Equipment, $35.95 to $73.75. Easy Payment Plan. Superior Oxy-Acetylene Machine Co., Hamilton, Ohio.

For Sale—Well equipped welding shop. Good location. Doing good industrial business. Established 13 years. Price $3500. Have other interests. Address Au-2, The Welding Engineer.

For Sale—Last 3600 ft. new welding cable, all rubber-covered, super-flexible type, factory short lengths, 40 to 135 ft.—No. 2 at 18c ft.; No. 1 at 20c; No. 1/0 at 26c; No. 2/0 at 30c. Metallizer Gun $100. Lincoln 300-amp. welding generator, all rebuilt, $185. Also 200-amp. A.C. elec. motor-driven with shaft extension $215. Governors, magnetic idlers. Address Au-4, The Welding Engineer.

New Cutting Torches at Used Torch Prices! That's an Opportunity Seldom Offered. Hurry! Hurry! Get 'em While They Last. Until October 1, you can buy a new cutting torch—the most modern—abuse proof—efficient—a torch that can really take it for ONLY $19.05 and your old torch complete with one tip. Immediate C.O.D. parcel post shipment. Send in your old torch after you have inspected your new torch. "HOT" RIDLON, P. O. Box 5891, Cleveland, Ohio.

POSITION WANTED

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Combination Welder—Welding school graduate. Limited exp. Will take apprentice job. Single, age 24, steady, dependable. References. Willing to go anywhere. Frank Avery, St. Paul, Ind.

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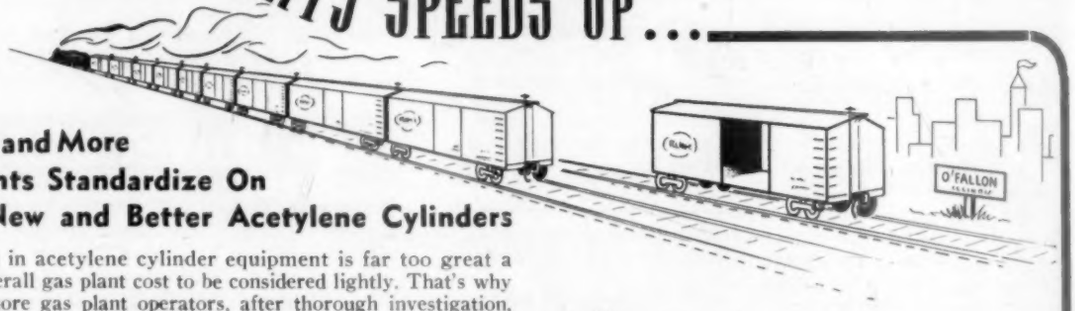

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